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OF THE

TEA RESEARCH INSTITUTE

OF CEYLON

THE TEA RESEARCH INSTITUTE,
St. Coombs, Talawakelle,
Ceylon.

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THE TEA QUARTERLY

VOLUME XXVII. MARCH/JUNE, 1956 PARTS I & II.

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THE TEA QUARTERLY

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DEVELOPMENTS IN BLISTER BLIGHT CONTROL

I. INTRODUCTION TO THE 1955 SERIES OF BLISTER BLIGHT CONTROL EXPERIMENTS

B. N. Webster and P. O. Park*

Previous work on the control of the blister blight disease of tea has been published in this journal in the series entitled "Studies in Blister Blight Control, I-XVI". This series was terminated in 1954 when, in the final paper, the title used above was suggested as suitable for the publication of future results. The papers in this issue accordingly represent the start of a new series in which the results of an extensive programme of experimental work designed to answer a number of outstanding questions will be reported. This work was carried out in co-operation with the research staff of Messrs. Fisons Pest Control Ltd., whose ready assistance in this joint research programme is most welcome.

Methods:—During the planning of the season's programme it was decided that, wherever possible, experiments should be designed in such a way that the results could be subjected to statistical analysis. This necessitated first of all a departure from the arbitrary method of assessment previously used (Loos, 1951a), and the institution of an assessment relying on a real numerical basis.

Two methods were chosen, both of which have been used previously in assessing blister blight attacks (Loos, 1951b). Each depends on the collection of flush from a given number of bushes selected at random in the area to be assessed, and the further random selection of a given number of shoots (usually 100) from this sample. It was decided that, for the purposes of assessment, shoots should be plucked to three leaves and a bud, the third leaf being chosen for the count of total blisters. The choice of the third leaf for blister counts is derived from the assumption that, on a short plucking cycle, many of the "second leaves" would not have been opened sufficiently long for infection to have reached a visible stage. During counting all blisters and "translucent spots" (Loos, 1951c) were counted. It was found in practice that the ability to distinguish translucent spots due to blister from those due to other causes was soon acquired. Further, it is the third leaf, which is normally left on the bush, which it is most important to protect. Results of counts were expressed as "total number of blisters on 100 third leaves" and as "percentage of infected shoots", *i.e.* the number of shoots per 100 whose third leaves carried blisters.

Random selection of bushes to be included in the assessment was made either by throwing a conspicuously painted stick, and selecting the nearest bush to its point of rest, or by the use of two tables of random numbers, one to designate the row to be chosen, counting from a fixed point, and the other to designate the number of the bush in that row. This latter method has the disadvantage of being applicable only to plots of regular shape and size, which are not always easy to fit in to the average tea field. It is a slower method and was only adopted in one of the field experiments.

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* Member of the staff of Fisons Pest Control Ltd.

It was further decided that this numerical assessment should be applied to numerous commercial estate fields, in which the superintendent concerned considered control to be adequate, in order that a realistic figure for satisfactory control could be reached. This was done, and a figure of approximately 35 per cent infected third leaves was regarded as showing satisfactory control to have been achieved. The practical application of this technique has been explained, for the guidance of superintendents, elsewhere (Portsmouth and Webster, 1955).

It was noted in all the 1955 trials that during the first four or five weeks of the south west monsoon infection levels as high as 70 per cent or more were experienced, no matter what fungicide was used, and this observation was paralleled by the observations of many superintendents. The explanation undoubtedly lies in the fact that little or no fungicide is retained by the leaf when spraying is done during rainfall, and when the rain force exceeds a certain level. It has been suggested (Haworth, 1950) that this figure lies between $1\frac{1}{2}$ and $2\frac{1}{2}$ inches of rain per hour. However, despite an initially high level of infection, an efficient fungicide appears able to reduce this level after 3 rounds of spraying, or five rounds of dusting.

Objects:—The programme was designed to test both existing and new formulations of copper and non-copper fungicides along the following lines of investigation:—

SPRAYS

(i) A statistical comparison of the relative fungicidal efficiency of copper oxide (yellow-red) and copper oxychloride (green) fungicides.

(ii) To test new formulations of copper in the control of blister blight.

(iii) To ascertain whether an improvement in the adhesive properties of a fungicide could result in a reduction in the rate of copper application without impaired efficiency.

(iv) To gain confirmation on the relative efficiency of fungicides of different particle size by the use of normal commercial fungicides and colloidal copper fungicides.

(v) To assay the fungicidal properties of two systemic antibiotic fungicides against blister blight, and of a non-copper organic fungicide.

DUSTS

(i) To evaluate the relative fungicidal efficiency of a commercially available blended copper dust and a coated copper dust.

(ii) To ascertain whether coated dusts could be satisfactorily employed on a longer round than blended dusts, thus enabling dusting to fit in better with estate plucking rounds, and effecting a reduction in cost of protection.

(iii) To test the fungicidal efficiency of three new 4% copper blended dusts, formulated with locally produced fillers.

(iv) To ascertain whether a coated dust could be diluted with inert filler without loss of fungicidal efficiency.

Methods:— 1. LAYOUT:—With the exception of the small scale trial carried out on St. Coombs No. 8 field (see Paper IV of this series, Park and Webster, 1956) all the field trials were on plots of 1/5 acre, or ½ acre, grouped in blocks, and with treatments suitably replicated. Plots were demarcated by double wires, guard rows of two bushes in width being left between the wires. Untreated plots were not included as a treatment in all of the experiments, as the purpose of the experiments was to compare the effect of the various fungicide treatments, and not to evaluate their absolute control. Further it was doubted whether untreated plots, which are completely surrounded by large areas of protected tea, would, in one season, achieve a blister blight level comparable to that of a completely unprotected tea area.

2. EQUIPMENT:—All spraying was performed with Birchmeier 'Senior' hand-operated knapsacks fitted with double nozzle sapphire lined jets, chosen for convenience of refilling when several different materials were in use. They gave an extremely satisfactory performance throughout the season. Spraying was done over two rows at a time.

Dusting was performed with a battery of 'Orient' hand dusters which, with the exception of points noted in the following papers, also gave a satisfactory performance with all the materials used. Dusting was done over 4 rows at a time.

3. FIELD OPERATIONS:—The plucking of the experiments came under the immediate control of the estate superintendent concerned, the other operations being fitted in with a plucking round arranged with the superintendent. Treatments were carried out on the day after plucking, or, when the programme necessitated it, on the day of plucking, the protection gang in the latter case following the pluckers through the field. No attempt was made to assess yield effects on the experimental plots, previous experience having shown such results to be meaningless. Assessments were made on the day before plucking, but occasionally on the same day, and on one or two occasions, when the many projects in hand made reorganisation of the programme impossible, assessment, plucking and treatment were carried out on the same day. Linen bags, numbered according to the plot, were used for the sampling of up to 100 shoots per treatment in each experiment. These were then assessed in the laboratory, and recorded on the basis described above. As a result of the rather late start made on the experiments, the first two assessments were rather high, but were regarded as invalid, as they reflected only the results of infection before treatments were begun. Analysis of results was made on seasonal mean figures.

Weather:—Typical monsoon conditions prevailed throughout the course of the experiments. An attempt has been made to investigate the effect of different aspects of the weather conditions on blister blight infection, findings of which will form the basis for a further paper in this series.

Reporting:—As a result of requests and complaints of preferential treatment from several commercial firms, it has been decided that in future experiments, products for trial by the Tea Research Institute will not be named in our publications except by special request. Further, the Tea Research Institute will not normally devulge the trade name of any product used as a standard of comparison, except to the suppliers thereof. As a result of this decision the standard fungicide to be used in future trials is likely to be varied between commercially available products shown by experiment to be of equal efficacy in blister blight control.

Acknowledgments:—The Tea Research Institute of Ceylon wish to acknowledge the assistance afforded by Fisons Pest Control Ltd. in the conduct of the 1955 series of joint experiments.

The Fisons Pest Control Ltd. author acknowledges the co-operation of the Director and staff of the Tea Research Institute, and thanks the Directors of Fisons Pest Control Ltd. for permission to publish.

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Haworth, F. (1950)—The effect of weather on copper residues. Tea Quarterly 21 (4), pp. 30–31.

Loos, C. A. (1951a)—Studies in blister blight control. VII. Power dusting with "Cuprosana" dusts containing 2, 4 and 6 per cent of copper. Tea Quarterly 22 (4), p. 131.

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DEVELOPMENTS IN BLISTER BLIGHT CONTROL

II. SPRAYING TRIALS IN 1955, USING 50% COPPER FUNGICIDES

P. O. Park*, B. N. Webster, and E. A. Jennings*

During the monsoon season of 1955 three spraying trials were carried out by the joint Fisons Pest Control Ltd. and Tea Research Institute team. Of these, two were carried out on St. Coombs estate, one being an attempt to introduce a small scale technique of assessing the efficiency of fungicides, and the other a field trial which is reported on below.

St. Coombs No. 6 field experiment

OBJECTS:— 1. To compare the efficiency of commercially available copper oxide and copper oxychloride fungicides. Although contrary to stated policy it was considered desirable that this information should be available for reference in the setting of standards for future experiments.

2. To assess the efficiency of a new formulation of copper oxychloride, with an improved adhesive, at half the normal dosage rate of copper.

3. To assess the efficiency of an experimental organic copper fungicide.

LAYOUT:—St. Coombs No. 6 field, pruned in December 1954, was chosen for this experiment, being accordingly divided into 16 approximately half acre plots, grouped into four blocks, A, B, C, D. The plots were numbered within the blocks according to the treatment to be applied, these treatments being randomised within the blocks. Each treatment was thus replicated four times.

Guard rows of two bushes in width were retained between all plots. The balance of the field was protected by the fungicide in general use on the estate, with the exception of two areas which were left untreated.

TREATMENTS

1. 'Perenox' (I.C.I. Ltd.) copper oxide fungicide (50% copper) at 6 ozs. per 12 gal. water per acre.

2. 'Blitox' (F.P.C. Ltd.) copper oxychloride fungicide (50% copper) at 6 ozs. per 12 gal. water per acre.

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* Members of the staff of Messrs. Fisons Pest Control Ltd.

3. 'Wet Blitox' experimental fungicide at the equivalent of one half the copper rate of the two above.

4. CAA experimental organic copper fungicide (50% copper) at 6 ozs. per 12 gal. water per acre.

Treatments were applied on an 8 day round, on the day following estate plucking, commencing on 13th May and continuing until 18th September, a total of 17 rounds. The apparatus used for application was the Birchmeier 'Senior' hand-operated knapsack.

Results:— 1. TAINT TESTS:—Routine taint tests were conducted on separately manufactured leaf collected from those plots receiving the two new fungicides. In no case was any taint apparent in the made tea throughout the course of the experiment.

2. The results of treatments were assessed by the method described in paper I of this series (Webster & Park, 1956), the choice of bush being made by the "stick-throwing" method, 25 bushes per plot being chosen. Assessments were made on the day before, or the day of plucking and expressed as (i) total number of blisters per 100 third leaves, and (ii) percentage of shoots infected on the third leaf. The means of the results over the whole monsoon season for the four treatments are shown diagrammatically in figure 1. Small blocks are incorporated in the diagrams superimposed on the tops of the principal columns of seasonal mean results of treatments. These blocks represent the standard error calculated during statistical analysis of the results. Thus, a statistically significant difference in favour of a treatment is shown when the upper limit of its small block falls below the lower limit of the small block of any other treatment under comparison; *e.g.* treatment 2 is significantly better than treatment 4, but not significantly better than treatment 1.

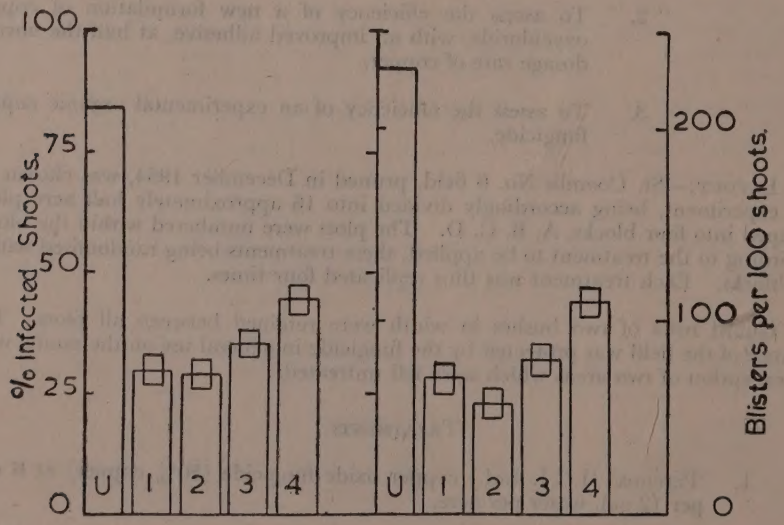

Fig. 1. Block diagrams representing the comparative degrees of control gained with treatments 1 — 4. U = untreated. The small blocks represent the standard errors at 5% level.

Analysis of results:—Statistical analysis of the results has yielded the following information:—

1. That there was no significant difference in the degree of control of blister blight afforded by copper oxide and copper oxychloride.

2. The experimental fungicide, Wet Blitox, applied at a rate equivalent to 3 ozs. per acre of a 50% copper fungicide, gave control almost as effective as that of the two standard products, despite the 50 per cent. reduction in copper content.

3. The 50% organic copper fungicide (C.A.A.) gave control of blister blight which was significantly less than that of the other three products in the experiment.

Discussion and conclusions:—The much vexed question of the relative merits of copper oxide and copper oxychloride fungicides has, under the conditions of the experiment, been answered to the effect that both are equally efficient.

Much has been said regarding the relative visibility of these two fungicides on treated leaves, but careful observation throughout the season has shown that low volume deposits of neither is easily visible on wet leaf. Although a copper oxide formulation may be more easily visible when freshly sprayed on to dry leaves, a copper oxychloride formulation is more easily visible as a dried-off deposit. From the point of view of supervision, therefore, much would appear to depend, from the visibility aspect, on the time of observation relative to treatment.

A moderately satisfactory level of control was obtained with treatment 3, when used at a rate equivalent to half the normal copper application per acre. This shows a considerable advance, which possibly results from the use of a more efficient adhesive agent. The short life of the plucking shoot of tea would, however, appear to suggest that improved fungicide adhesion is only a doubtful advantage for tea, and possibly other factors are operating in the efficiency of the formulation. Further, other experiments to be reported in later papers in this series have shown satisfactory control to be obtainable with even greater reduction of copper content, thus further investigation of the actual reasons for the improvement under discussion may prove to be of academic interest only.

The organic copper fungicide used in this experiment did not give control up to the standard of commercially available fungicides, and further work on it is not contemplated.

Acknowledgments:—The joint authors express their thanks to all those concerned in the day to day conduct of the experiment and to those firms which supplied the fungicides. The Fisons Pest Control Ltd. authors acknowledge the co-operation of the Director and staff of the Tea Research Institute and thank the Directors of Fisons Pest Control Ltd. for permission to publish.

Reference

Webster, B. N. and Park, P. O. (1956)—Developments in blister blight control. I. Introduction to the 1955 series of blister blight control experiments. Tea Quarterly 27 (1 & 2), pp. 3-6.

DEVELOPMENTS IN BLISTER BLIGHT CONTROL

III. DUSTING TRIALS IN 1955, USING 4% COPPER BLENDED DUSTS

P. O. Park*, B. N. Webster and E. A. Jennings*

Of the three dusting trials carried out by the writers during 1955 one was on St. Coombs estate and two on Mattakelle estate. That on St. Coombs was designed to use 4% blended copper dusts manufactured with locally produced fillers. The use of locally produced copper dusts is standard practice in Java and Sumatra, and has contributed substantially to the maintenance of relatively low crop protection costs in those countries and all the three locally produced fillers are available in sufficient quantity to make local production of blended copper dusts an economic possibility. Two commercially available 4% copper dusts and one specially prepared 3% dust were also included in the trial.

St. Coombs No. 2 field experiment

OBJECTS:—

1. To compare the efficiency of a 4% blended dust and a 4 % coated dust in the control of blister blight. Although this constituted a departure from stated policy the information was required for the setting up of standards in subsequent trials.

2. To assess the efficiency of three new 4% coated dusts, based on copper oxychloride blended with locally produced fillers (arbitrarily numbered 1, 2 and 3), by comparison with two commercially available 4% copper dusts, one a blended dust, and the other a coated dust.

3. To ascertain whether a reduction in copper content, and a consequent saving, can be achieved without loss of control, by the dilution of a 6% coated dust with its own weight of filler.

LAYOUT:—St. Coombs No. 2 field, pruned in June 1954, was the area chosen for this experiment, being divided into 5 blocks (A to E), each subdivided into six plots of approximately 1/5 acre. The regular shape of the field enabled almost all the plots to be laid out as rectangles of 20 × 30 bushes, thus enabling the random number sampling technique to be employed (Webster and Park, 1956). Guard rows of two bushes in width were retained between all the plots.

Three irregularly shaped plots were left untreated, whilst the six treatments were randomised within the five blocks.

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* Members of the staff of Messrs. Fisons Pest Control Ltd.

TREATMENTS

1. Blended dust, filler No. 1 (4% copper) 5 lbs/acre every 6 days.
2. Blended dust, filler No. 2 (4% copper) 5 lbs/acre every 6 days.
3. Blended dust, filler No. 3 (4% copper) 5 lbs/acre every 6 days.
4. 'Blidust' 6% copper (F.P.C. Ltd.), diluted 50/50 with filler, 5 lbs./acre every 6 days.
5. 'Blidust' 4% copper (F.P.C. Ltd.), 5 lbs./acre every 6 days.
6. 'Cuprosana' 4% copper (Universal Crop Protection, Ltd.) 5 lbs/acre every 6 days.

Dusting was carried out in 6 day rounds on the day following estate plucking, commencing on 11th May and continuing until 20th September. Dusting of the experimental plots was carried out using the 'Orient' hand dusting machine, whilst the balance of the field was protected with 'Cuprosana' dust applied by means of the 'Kestrel' hand duster which was undergoing test.

Results:—1. TAINT TESTS:—Leaf from all plots receiving the new formulations was taint tested throughout the course of the experiment, with negative results.

2. Results of treatments were assessed by the method previously described (Webster and Park, 1956), the choice of bushes being made by the random number method, ten bushes per plot being plucked. Assessments were made on the day before, or the day of plucking, in every other plucking round, and expressed as total blisters on 100 third leaves, and percentage of shoots with infected third leaves. The mean results for the six treatments during the season are shown in figure 1. For an explanation of the significance of the diagrams reference should be made to paper II of this series (Park, Webster and Jennings, 1956).

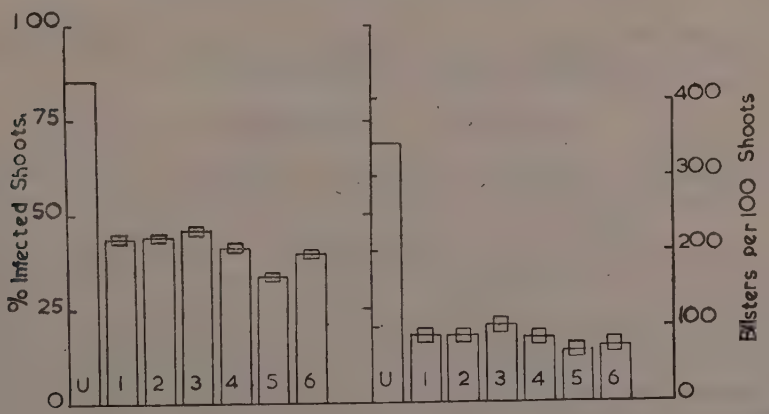

Fig. 1. Block diagrams representing the comparative degree of control gained with treatment 1 — 6. U = Untreated. The small blocks represent the standard errors at 5% level.

Analysis of results:—Statistical analysis of the results has yielded the following information:—

1. That the three new blended dusts afforded satisfactory protection from blister blight.

2. That, under the conditions of the experiment, the performance of the coated dust (Blidust 4%) was significantly better than that of the three new blended dusts, but only significantly better than Cuprosana and the Blidust 6% diluted 50/50 when the percentage of infected shoots was chosen as the criterion of assessment. Similarly it is only on this criterion that the standard blended dust, Cuprosana, was significantly superior to the new blended dusts; the differences are not significant on the other assessment method.

3. That Blidust 6% diluted 50/50, *i.e.* to 3% copper content, afforded protection equivalent to that of the standard 4% blended dusts. On the criterion of percentage of infected shoots, it was somewhat superior to the new blended dusts, but not when the number of blisters per 100 shoots is the assessment criterion.

Discussion:—As previously mentioned in paper II of this series (Park, Webster and Jennings, 1956) the initial assessments made during the first month of the monsoon showed an extremely high incidence of blister blight but, as weather conditions began to show a slight improvement, all the treatments used in this experiment showed themselves capable of maintaining an adequate level of control. Blidust 4% maintained throughout a slight superiority over the other treatments, when assessment was made on percentage of infected shoots present, but, when made otherwise (*i.e.* on total blisters per 100 third leaves), Blidust 4%, Cuprosana and Blidust diluted to 3% gave equivalent results.

The three new dusts gave a satisfactory performance with the Orient duster, and very little trouble was experienced with any of the dusts. Blidust 4% showed an occasional tendency to collect in the inlet tube of the Orient duster, under the hopper outlet, but it is believed that this trouble may be corrected by constricting the inlet tube at this point, thus creating a Venturi effect. The Kestrel hand duster performed very satisfactorily, and has been reported on elsewhere.

Conclusions:—It has been satisfactorily demonstrated that blended copper dusts for the control of blister blight, manufactured from locally produced materials, are capable of achieving an adequate degree of control.

Mattakelle No. 7 field experiment

Objects:—1. To compare the efficiency of a coated dust at two intervals of application.

2. To compare the efficiency of dusting with a coated dust, and spraying with a recognised copper oxychloride, at the same intervals of application.

Layout:—Mattakelle No. 7 field, pruned in June 1953, was selected for this experiment and was divided into 1/5 acre plots, grouped in blocks of either 4 or 5 per block. The treatments listed here were part of a larger experiment to be reported later, and were randomly distributed in 4/5 fold replication over the whole field. Guard rows of two bushes were retained between plots. The balance of the field was protected with a commercially available copper oxychloride except for four untreated areas. Statistical analysis of the part experiment is not possible, and thus only the mean assessments of blister level for the period of the experiment are plotted in the block diagrams. In order to fit in with estate plucking rounds, the intervals between applications had occasionally to be modified by $\pm$ 1 day but an average frequency of spraying or dusting as shown below was maintained.

Treatments

1. 'Blitox' (F.P.C. Ltd.) copper oxychloride fungicide (50% Cu) sprayed at 6 ozs./15 gallons/acre 8 daily.

2. 'Blidust' (F.P.C.Ltd.) 4% coated dust applied at 5 lbs/acre 6 daily.

3. 'Blidust' (F.P.C. Ltd.) 4% coated dust applied at 5 lbs/acre 8 daily.

Results:—The method of assessment of blister blight control was as described in paper I of this series (Webster and Park, 1956), using the stick throwing method for selection of the bush. The mean results for the last 13 assessments out of the 15 made are given in figure 2.

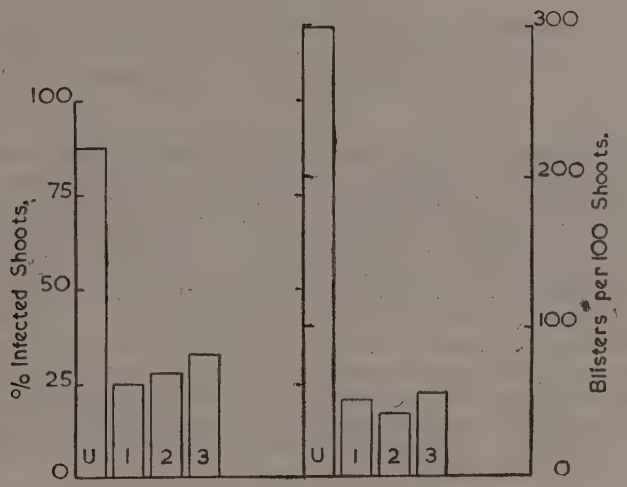

Fig. 2. Block diagrams representing the comparative degree of control gained with treatments 1 — 3. U = Untreated.

Discussion and conclusions:—As mentioned above, statistical analysis is not possible; however it can be seen from the diagrams that 6 and 8 daily applications of a coated dust are almost equally effective. Spraying, and dusting with a coated dust, at the recommended time intervals of 8 and 6 days respectively are equally effective and at equal intervals are almost equally satisfactory.

Acknowledgments:—The assistance of the Ceylon Institute of Scientific and Industrial Research in the preparation of three blended dusts is gratefully acknowledged, as is supply of Cuprosana from Messrs, Harrisons and Crosfield. Thanks are also due to the superintendent and to Messrs. Boustead Bros. Ltd, for permission to use part of Mattakelle estate. The joint authors willingly thank the field assistants, who helped to make the programme possible. The Fisons Pest Control Ltd. authors are pleased to acknowledge the co-operation of the Tea Research Institute, and thank the Directors of Fisons Pest Control Ltd. for permission to publish.

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DEVELOPMENTS IN BLISTER BLIGHT CONTROL

IV. SMALL SCALE ASSAY OF FUNGICIDES

P. O. Park* and B. N. Webster

The experimental methods for determining the degree of protection afforded by a fungicide as described in previous papers of this series, while giving a completely satisfactory assessment of the efficiency, are both time and space consuming and require an appreciable number of field staff. For instance, the comparison of four experimental dusts against two commercially available fungicides described in paper III (Park, Webster and Jennings, 1956b) required a tea field of 8 acres, a dusting gang of four every 6 days, three pluckers at similar intervals, with three field assistants on each of the dusting and plucking days. These methods are necessary for a complete assessment; however, with the shortened technique described below, we were able to do a preliminary screening of a larger number of compounds and treatments with considerable reduction in acreage and labour. Certain treatments included in the No. 6 field experiment (Park, Webster and Jennings, 1956a) were repeated in this small scale trial in order to get a comparative assessment of the validity of the new technique.

In order to apply the appropriate spray volume for the small plots, it was necessary to design a total delivery hand sprayer, to which any desired commercial nozzle could be attached, to be operated from the pressure tank of a knapsack sprayer.

Copper fungicides alone have proved economically satisfactory in the control of blister blight, but the possibility of excessive residues in the made tea when the recommended intervals between treatment and plucking are not maintained makes it desirable to find substitutes. The high cost of the raw material is also an encouragement to find low-copper or non-copper alternatives. In the screening programme to be described were one organic (non-copper) fungicide and two antibiotics. Each was applied at 2 or 3 dosage rates which were likely to be economically competitive with the standard copper fungicides. In addition, from the various treatments applied it was possible to make some tentative comparisons of various properties of copper fungicides whch have been said to affect efficiency.

St. Coombs No. 8 field experiment. Small scale trials

Objects:—1. To develop the preliminary screening test.

2. To observe the effect of reduced dosages of standard fungicides.
3. To compare cuprous oxide fungicides with copper oxychlorides (cf. Paper II).
4. To compare 'Wet Blitox' at the equivalent of ½ copper rate with standard fungicides.

* Member of the staff of Messrs. Fisons Pest Control Ltd.

5. To determine if the adhesive used in 'Wet Blitox' is equally efficient with cuprous oxide.

6. To compare an organic copper adhesive formulation with standard fungicides.

7. To assess the fungicidal efficiency of two new cuprous oxides.

8. To study the effect of particle size on the efficiency of both copper oxychloride and cuprous oxide.

9. To assess the efficiency of an organic fungicide and two antibiotics against blister blight.

Layout and description of method:—A block in St. Coombs No. 8 field, unprotected section, pruned in June 1953 and skiffed in April 1955, was used for this experiment. 11 rows of 20 bushes each were divided up into 51 plots of 4 bushes in the row, and the plots were grouped in 3 blocks, each of 17 plots, labelled A, B, C. The plots in each block were numbered according to the treatment applied, giving 3-fold replication of the randomized treatments. No guard rows were allowed, as the spray from the total-delivery hand sprayer, represented in figure 1, was sufficiently directional not to lead to drift. 68 cc. of the spray of the appropriate concentration was measured into the hand sprayer. This was then connected to the lance of a knapsack sprayer and the whole contents of the spray vessel were sprayed evenly on the plot of 4 bushes. This is approximately equivalent to 15 gallons per acre.

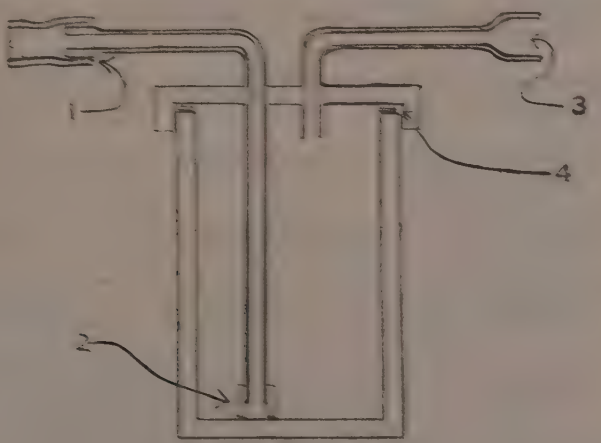

Fig. 1. Sectional diagram of total delivery hand sprayer.

(1) Commercial spray nozzle 'Birchmeyer sapphire-lined' screwed to outlet. (2) Rubber tube sleeve, to ensure as complete delivery of spray liquid as possible. 3 Screw connection to spray lance. 4) Screw-threaded connection with leather gasket between lid and vessel for easy filling.

Treatments

1. 'Blitox' F.P.C. (Ltd.) 50% copper as $CuSO_4$ at 6 ozs. per 15 gallons per acre (= 0.17 gm, 68 cc/plot).

2. 'Perenox' I.C.I. Ltd. 50% copper as Cu_2O at 6 ozs. per 15 gallons per acre (= 0.17 gm, 68 cc/plot).

3. 'Collavin Pur' (50% copper as Cu_2O) at 6 ozs. per 15 gallons/acre (= 0.17 gm/68 cc/plot).

4. 'Collavin Pur' + adhesive at equivalent of 1.5 oz. Cu per 15 gallons per acre.

5. 'Blitox' + adhesive ('Wet Blitox') at equivalent of 1.5 oz. Cu per 15 gallons/acre.

6. Adhesive formulation based on copper napthenate at equivalent of 1.5 oz. Cu per 15 gallons/acre.

7. Experimental fungicide HD160 at 0.24 oz/15 gallons/acre (= 0.007 gm/68 cc./plot).

8. Experimental fungicide HD160 at 2.4 oz./15 gallons/acre (= 0.068 gm/68 cc./plot).

9. Colloidal copper oxychloride at equivalent of 2 oz. Cu/15 gallons/acre.

10. 'Blitox' at equivalent of 2 oz. Cu/15 gallons/acre.

11. 'Perenox' at equivalent of 2 oz. Cu/15 gallons/acre.

12. 'Cupfer Oxydul Ultra' (Schering A.G.) at equivalent of 2 oz. Cu/15 gallons/acre.

13. 'Griseofulvin' at 0.12 oz. a.i./15 gallons/acre (= 0.18 cc. liquid concentrate/68 cc./plot.)

14. 'Griseofulvin' at 0.36 oz. a.i./15 gallons/acre (= 0.53 cc. liquid concentrate/68 cc./plot).

15. 'Griseofulvin' at 1.1 oz. a.i./15 gallons/acre (= 1.6 cc. liquid concentrate/68 cc./plot).

16. 'Streptomycin' at 0.60 oz. a.i./15 gallons/acre (= 0.27 gm. 15% technical/68 cc/plot.

17. 'Streptomycin' at 2.4 oz. a.i./15 gallons/acre (= 1.09 gm. 15% technical/68 cc./plot).

These treatments were applied at 7 daily intervals, commencing on 1st July and sample plucking was 6 days after each spraying; 8 complete rounds were taken. The total flush from each plot was plucked, including third leaves, and 33 shoots were selected at random from this flush sample for blister counts on the third leaves. The sum of the results from the three replicates of each treatment were expressed as total blisters on 100 shoots and as a percentage infected shoots in an analogous way to that described in paper I of this series (Webster and Park, 1956). The made tea from leaf treated with the adhesive formulation No. 6 was taint tested a number of times during the experiment.

Results.—1. The mean results for the 17 treatments from assessments 3-8 inclusive are shown as block diagrams in figures 2 and 3. For an explanation of the significance of these diagrams reference should be made to paper II of the series (Park, Webster and Jennings, 1956a).

2. Formulation No. 6 did not result in taint of tea.

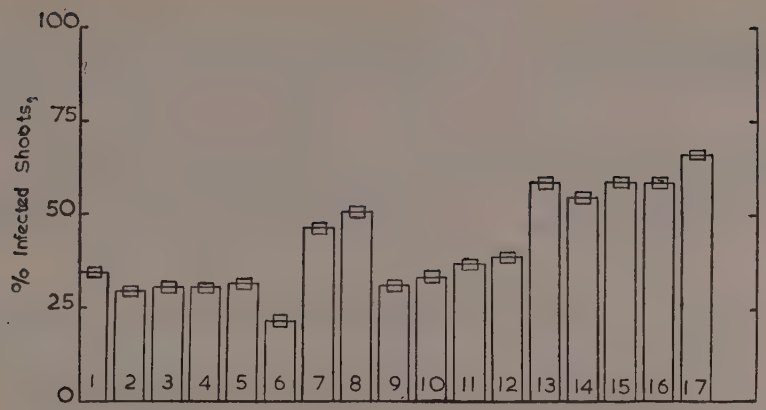

Fig. 2. Block diagram representing the comparative degree of control, based on percentage infected shoots, gained with treatments 1 — 17. The small blocks represent standard errors at 5% level.

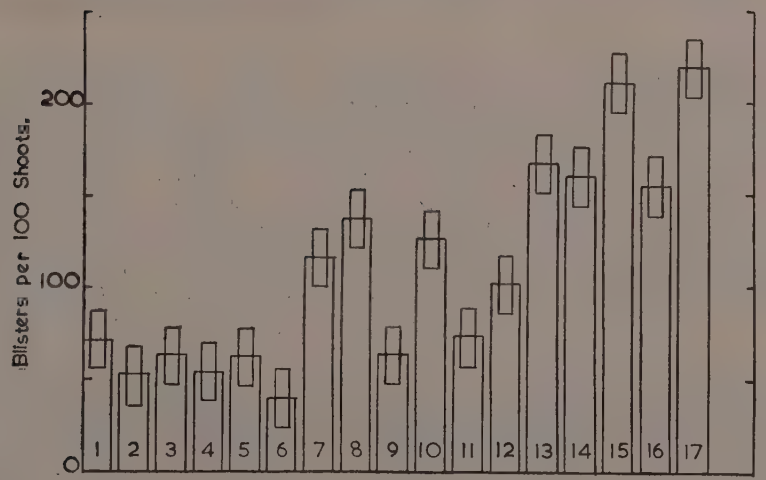

Fig. 3. Block diagram representing the comparative degree of control, based on total blisters per 100 shoots, gained with treatments 1 — 17. The small blocks represent standard errors at 5% level.

Analysis of results.—The statistical analysis of the results of this experiment lead to the following conclusions being drawn:—

1. The protection obtained when the dosage of standard fungicides is reduced from 6 oz. (treatments 1, 2 and 3) to 4 oz. per acre (treatments 9, 10, 11, 12) was somewhat less, but this difference was not significant for some comparisons.

2. There is little or no difference between copper oxychloride and cuprous oxide fungicides (treatments 1 v. 2 and 3; 9 and 10 v. 11 and 12) cf. the similar conclusion listed in paper II of this series.

3. Wet Blitox is practically as efficient as the standard fungicides when applied at the equivalent of half the usual copper rate (treatments 1, 2 and 5) and the adhesive is equally satisfactory with cuprous oxide (treatment 4).

4. The organic copper adhesive formulation is, at half the usual copper rate at least as good as the standard formulations (treatments 6 v. 1 and 2).

5. The new cuprous oxide fungicides were as satisfactory as standard fungicides applied at the same dosage (treatments 3 v. 1 and 2; 12 v. 10 and 11).

6. There is little or no advantage in the use of copper fungicides of colloidal or near colloidal particles (treatment 9), providing the material remains satisfactorily suspended in the sprayer (treatments 9, 10, 11, 12).

7. The experimental organic fungicide was inferior to the standard copper compounds in the control of blister blight, at the dosage rates studied (treatments 7 and 8).

8. The antibiotics (treatments 13-17 incl.) were inferior, at the dosages used, to copper compounds.

Discussion:—The small scale technique for the screening of 17 treatments required one field assistant on two days, together with one spray labourer and one plucker for one day each, and occupied approximately 1/20 acre. Thus its objective of economy of time, labour and acreage of tea was certainly achieved. However, an examination of the results shows that the replicate variations for a number of treatments are wider than is usual with larger plots. Thus for mixed-jat tea a plot size of 4 bushes would appear to be too small and the adoption of a somewhat larger plot size is desirable. The constancy of the block totals and means suggests that 68 bush plots would be completely adequate. Probably some lesser number of bushes could be chosen. The Tea Research Institute will develop the method further in future seasons and 10 bushes seems to be a probable reasonable plot size.

As it was not possible to start this experiment at the beginning of the monsoon, the previously unprotected section of No. 8 field at St. Coombs was selected as the site, in order to have a high blister level and thus a more sensitive assessment of the fungicides. Experience led us to the conclusion that this was an unfortunate choice, since the long attack of blister that this tea had suffered resulted in some bushes producing little or no flush. This no doubt contributed to the wide replicate variations mentioned above. In future experiments a reasonably uniform block of healthy tea will be selected. In addition certainly not less than the 8 assessments used in this case should be used.

Returning to the experiment as reported above, while it is probable that it can be improved, it is clear that, with fungicides shown to be effective against blister blight, it did not give misleading results. The comparison of a standard cuprous oxide fungicide against a copper oxychloride at two dosage levels and the performance of the adhesive formulation Wet Blitox are a close parallel with the corresponding results reported in paper II (Park, Webster and Jennings, 1956a). Thus it is very unlikely that the conclusions drawn regarding the almost ineffective non-copper fungicides are erroneous as a result of imperfect technique.

Conclusions:—A reasonably satisfactory small scale screening method for fungicides against blister blight was developed. All copper-containing compounds were effective, there being some advantage in using the adhesive formulations tried, but little or none in using colloidal materials. Non-copper fungicides were not satisfactory.

Acknowledgments:—The authors wish to thank the firms which donated samples for this trial. The Fisons Pest Control Ltd. author thanks the Director and staff of the Tea Research Institute for their assistance and the Directors of Fisons Pest Control Ltd. for permission to publish.

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MISCELLANEOUS NOTES ON MANUFACTURE

E. L. Keegel

Continuous Rolling.—A method of rolling that is becoming popular in up-country districts is one in which the dhool taken out at the end of each roll is replaced by withered leaf. The process is continued till the end of the day, and the big bulk finally reduced to a very small proportion of the day's make. This method should not be confused with another procedure of old standing in which the big bulk is continuously rolled.

To the inexperienced who contemplate adopting continuous rolling many pitfalls are likely to be encountered in the early stages and the following points should be carefully considered. First is the question of dhool outturns and next comes the question of fermentation. For continuous rolling to give staisfactory results these two must be examined in relation to the intake of the drier. Another and very important point to bear in mind is that the rollers should not be charged initially up to normal capacity. In fact the success of continuous rolling rests on manufacture being started with a roller partly full, because better rolling of the leaf is thus obtained. In normal orthodox rolling more machines will be required to fulfil these conditions. Finally, the intital charge should as far as possible not be greater than what the drier or driers can handle in 100 minutes. It will, of course, also depend on the rolling equipment and dhool producing capacity, but in any case should not exceed a 2 hours' drier intake.

For guidance as to the planning of a programme the following general rules may be found helpful (assuming rolling periods are to be of 30 minutes duration each, roll-breaking 10 minutes, and the charging interval 40 minutes):—

(1) First determine the drier intake in terms of pounds of withered leaf per hour.

(2) Then calculate the amount of withered leaf required to keep the drier full for 120 minutes, 100 minutes, 40 minutes and 35 minutes.

(3) The dhool which must be produced should then be approximately equal to the intake for either of the two shorter periods, and the initial charge to the intake for either of the two longer periods. That is to say, the dhool outturn should be 33 per cent., more or less.

(4) The weight of the intial charge should thus correspond to a drier intake of 100 minutes or 120 minutes or say, to some period between these two.

(5) Subsequent charges must be roughly equivalent to one third of the initial charge, and the dhool produced should also be near about this figure.

(6) In practice it will not be possible to obtain such a large dhool outturn in the early rolls, but if about 20 per cent. is taken out in the first rolls, and 25 per cent. aimed at in the next, a steady dhool outturn of about 33 per cent. of the intial charge can easily be obtained in subsequent rolls.

(7) It is not necessary to replace the dhool taken out with an exact amount of withered leaf. In any case it is not practicable. Neither is it absolutely necessary to have a constant charge, but dhool production is easier to regulate if a fixed amount of withered leaf is charged each time.

(8) The ultimate aim should be to get an amount of dhool that is not very much less than what the drier can handle for the interval between two successive rolls.

(9) The dhools are then fired in the order in which they are produced, keeping the drier continuously fed.

(10) The time firing should start must not be based on the fermentation required for the first dhool, as is generally done in orthodox rolling. If this practice is followed in the case of continuous rolling, the later dhools may not get the correct fermentation.

(11) The period of fermentation given to the first dhool must be such that the third and subsequent dhools do not get more than $2\frac{1}{2}$ hours fermentation, unless colour in the liquor is the only consideration. By a suitable adjustment a balance can be struck between quality and colour, a matter that can only be decided by trial and error.

(12) Since the first dhool represents only a very small proportion of the total day's leaf, it will not matter what fermentation it receives so long as the correct fermentation is given to the rest of the leaf.

(13) Fermentation is also regulated by dhool outturn. Continuous rolling necessitates shortening of the fermentation towards the end of the day, and this is achieved by the simple expedient of getting a weight of dhool which will take a few minutes less to fire than the charging interval. If the drier is kept continuously loaded, frementation will get shorter and shorter as manufacture proceeds. It may be necessary in some cases to come down to less than 2 hours and experience will show the lowest limit.

The system allows plenty of latitude, is actually simpler to operate than conventional rolling and can be recommended for estates which have difficulty in improving the colour and strength of liquors. It is not however very suitable during the 'flavoury' season.

Conservation of Flavour.—Just as for the development of quality in a high grown tea, the essential requirement for getting the best results when flavour is present is hard rolling. At the same time fermentation should be short. It is still the practice on some estates to have a different rolling programme for the 'flavoury' season, in the belief that flavour is lost by hard rolling. Softer withers are also taken with one objective in view, namely to keep the temperature of the leaf as low as possible in the rollers. At times the total rolling period is also shortened for fear that flavour will be ruined by even the smallest rise in temperature during rolling. Undoubtedly, the greatest enemy of flavour is excessively high temperatures, but this exaggerated fear of heat in rolling has unfortunately in many cases resulted in the adoption of light rolling with detriment to the development of flavour.

Experimental evidence of the influence of temperature has always indicated the desirability of warmth in rolling (vide *Tea Quarterly*, Vol. XXVI, Part III, pages 96-107) and to confirm the results obtained, with respect to flavour, an experiment on a full commercial scale was carried out in February this year at St. Coombs, at a time when most estates in the Dimbula districts were producing really fine teas. The hardest possible rolling was given to the leaf, so much so that its temperature at

the end of each roll was not less than 85°F. Fermentation was accordingly shortened, and the result was a tea that evoked the highest praise from tea tasters in Colombo and London. It threw into the shade some of the best teas made during this "vintage" season.

Details of the manufacture may be of interest to the reader:—

PERIOD OF WITHER:—morning leaf 10 hours (approx.)
noon leaf 7 „ „
evening leaf 4 „ „

DEGREE OF WITHER:—46 per cent. outturn of made tea to withered leaf. Great care was taken to prevent the leaf from over-withering in order to reduce greenness of liquor, a characteristic generally prevelent in very dry weather.

ROLLING:—4 × 30 minute rolls.
% DHOOL OUTTURN:— 1 — 20
2 — 24
3 — 28
4 — 14
BB — 8
Loss — 6

TEMPERATURE:— at end of 1st. roll — 85°F
(OF LEAF) „ 2nd. „ — 85°F
„ 3rd. „ — 87°F
„ 4th. „ — 88°F
(average rolling room temperature — 65°F (dry): 60°F (wet)).

ORDER OF FIRING DHOOLS:—1.2.3.4. BB.

OVERALL PERIOD OF FERMENTATION:—2½ — 3 hours.

TEMPERATURE OF FIRING:—190°F.

% OUTTURN OF B.O.P.:—68.

It is worth mentioning that the B.O.P. from an invoice made on these lines fetched in auction Rs. 6.25, the highest price ever paid for a St. Coombs' tea.

Increasing Outturns of O.P. and Fannings Grades.—Of late the demand for O.P. and fannings by the trade has led to another change in rolling technique and in the desire to increase the outturns of these two grades some estates appear to have overlooked the influence on the other grades.

In the low-country, which normally produces the highest outturn of O.P., the temptation to make still more of this grade is always present. The greatest care must, however, be taken to see that this result is not obtained by under-rolling. A very satisfactory outturn of O.P. may more often than not be procured at the expense of some of the other grades, which as a result of under-rolling will suffer in appearance and liquor.

In a few up-country factories the other extreme of over-rolling is resorted to with a view to getting unduly high fannings outturns. Not only is very small roll-breaker mesh employed, but the tea is also sometimes cut to excess. Here again appearance of the tea is sacrificed and the liquoring properties of the B.O.P. grade are naturally adversely affected, due to some of the finer leaf going into the fannings grade. The improved liquor of the latter may lead to a false sense of values.

It is strongly urged that both these extremes be avoided.

The Infra Red Moisture Tester.—This instrument, on account of its simplicity and reliability, has now come to be a recognized part of the accessory equipment in a tea factory.

The importance of checking the moisture content of teas leaving the factory need hardly be stressed, and, if the instrument is to serve this very useful purpose as accurately as possible, it must be used strictly in accordance to the instructions supplied by the agents.

One very important point apt to be overlooked when setting the lamp is the locking of the stop ring. If the screw holding it is not sufficiently turned the position of the ring will shift with use and the height of the lamp above the pan will thus be altered. It is necessary therefore to check from time to time the distance between the lowest point of the lamp and the upper edge of the housing, as indicated in the instruction schedule.

Another thing which should be watched is that part of the instrument housing the pendulum and knife edges. These should always be free from dust and before a moisture determination is made it is also advisable to make sure that no particles of tea have accidentally fallen on the beam while the pan is loaded.

VEGETATIVE PROPAGATION IN TEA (ITS PRACTICAL APPLICATION)

R. J. S. Bean

(Ederapolla Group, Bulathkohupitiya)

This article by a well known low-country planter should serve to convince any remaining sceptics that, given the necessary interest and enthusiasm on the part of the superintendant, vegetatively propagated material is perfectly suitable for growing under low-country conditions. Mr. Bean's own experience amply demonstrates that successful replanting with selected, high yielding, clonal material is neither more difficult, once techniques suited to local conditions have been developed, nor more expensive than replanting with unselected seed. The fact that, once established, vegetatively propagated bushes have been found to be more drought resistant than seedling bushes is also worthy of note.

These notes are written with the idea of co-ordinating the experience gleaned since 1948, when I wrote my first article on the subject of vegetative propagation.

It is hoped that the results achieved may be of assistance to those Proprietors and Companies who intend to embark on large scale replanting or new planting with clonal material. I should, at the outset apologise for quoting my own experience *in extenso* as this may presumably be interpreted as a medium of self-advertisement, which it most certainly is not. The fact is that by reason of reserve land, and the transposition of old rubber land to tea I have perhaps been more fortunate than most on the practical aspect of V. P. research, and, perhaps what is more significant, in being placed in a position of being able to assess the comparative performances of V. P. as against seedling clearings of exactly equivalent vintage and with adjacent terrain and indentical cultivation methods. I hope I may be excused in referring to my original article as some of the remarks and conclusions therein reached may now need rectification, clarification or expansion. It should again be emphasised that these experiments have been carried out in a south west district, subject to severe droughts, at an average elevation of 800 feet, and a badly distributed rainfall of 160 inches a year. It is not, therefore, suggested that the methods employed will necessarily be successful in other districts with varying climatic conditions, although I am of the personal opinion that the principles adumbrated are fundamentally and universally sound. Growth and development of clearings, of course, will be progressively slower in proportion to altitude.

Original Selection of Mother Bushes.—This technique is now well known to planters and needs no further elaboration. Generally speaking an initial selection of perhaps 50 mother bushes per 100 acres of cultivated tea would be reasonable and, for low-country, I would suggest that the yield factor (plucking points) should be the main, if not the only, criterion, in this primary selection.

Test Plots.—The next stage would be to establish, via the nursery, rows of say 50 or 60 bushes of each clone, in experimental plots, preferably adjacent, and in a surveyed area, so that clonal, and field yields may be readily available. Thus, on a stand of 6,000 bushes to the acre, 100 clones could be tested out, and the individual (clonal) and aggregate (multi-clonal) yields ascertained.

After perhaps four years, the discarding process can be commenced after preliminary yield trials, or if not already done, for reasons of horizontal or poor rooting, poor manufacture, or other undesirable characteristics. In a further two years an estate should be in a position to identify its outstanding clones and concentrate on proved high yielding material for all future replanting or supplying programmes.

Between 1947 and 1954, I was able to reduce this estate's clones from an original 974 to the present 12, and, with the addition of a few T.R.I. clones, we are concerned here with 20 first class clones only for future work.

It may be of interest to readers that a surveyed 2½ acres of 100 primarily selected mixed clones, planted in 1948, gave in 1955 a yield of 2,370 lbs. of made tea per acre, compared with 1,231 lbs. from a seedling area of the same vintage. For the same year an assessment, after test plucking for 3 months our best 20 clones (50 bushes of each), gave calculated yields of between 4,916 and 5,796 lbs. per acre of made tea. Although naturally it is not claimed that such astronomical figures could be obtained over large acreages, I am quite confident that yields in advance of 3,000 lbs. per acre will be achieved.

Nursery Technique.—The procedure described in my previous article has proved fully effective here and we are able to maintain an average of between 75 to 80 per cent. success throughout the year. Despite regular watering the percentage drops as low as 50 per cent. in drought months and reaches 95 per cent. in months when rainfall is well distributed. Hersall or cylinder transplantation is recommended only where experimental work is being done with valuable material. In ordinary commercial planting it is not economically justified because of (*a*) the prohibitive extent and cost of nurseries and (*b*) the tremendous cost of transplantation to the field.

We have found one acre of nurseries more than adequate to supply up an average of 30 acres of V.P. replanting per annum, or sufficient to maintain 300,000 cuttings. Leaf cuttings can be placed at distances of an inch apart in nursery beds and space can be further conserved if the leaf is halved.

In dry weather watering at dawn and dusk is imperative and I have found fern shading quite adequate. In no circumstances should cuttings be removed to the field in under 9 months and they can with advantage be left up to 15 months, if planting out is done in monsoon weather.

Transfer to field.—Experience has amply demonstrated that in the early stages V.P. material is much more sensitive than seedling and it is vital that immature V.P. plants should on no account be used in the field *i.e.* under 9 months of age in low-country conditions.

The time of planting is also vital and in the south west monsoon districts the only really safe period is at the outset of the south west monsoon rains, when up to 2 months wet weather can be safely anticipated.

Extreme care must be taken in transplantation not to injure or compress the tender laterals and this work requires the strictest supervision. In view of their early susceptibility to drought, good top soil is desirable for establishment with constant attention to hand forking, manure, shade and after care generally.

Field Technique.—It may sound presumptuous to expand on this subject as there are many and various methods of planting out tea, according to type of land, elevation and climate etc. and the varying whims of visiting agent and superintendent. It may, however, be of interest to relate the procedure adopted here, with success and relative economy, in regard to old rubber land. The rubber trees were felled

and utilised as firewood in January/March of the year prior to planting. The area was lined on the contour (4′ × 1½′) and trenches cut 1′ × 1′. Guatemala grass was then established between the rows. Gliricidias were planted in every 3rd. row (12′) and *Albizzia sumatrana* in every 12th. row (48′ × 48′), giving an abundance of shade for later thinning out. Weeds and loppings were placed in the trenches for mulch, and all planting completed by the end of July of the following year.

Drought resistance.—One of the original objections to replanting with V.P. material was a doubt expressed that, by reason of the lack of tap root, the vegetative material would not stand up to prolonged drought conditions.

In the early stages (up to 2 years) it is indeed true that V.P. material is very susceptible to drought and requires the utmost care until complete establishment in the field. After maturity there is to my mind no doubt whatsoever, and this is borne out by experience and visual observation, that V.P. material in production is very much more hardy than the seedling counterpart.

I have seen V.P. tea yielding vigorously and profusely after a month's severe low-country drought whilst seedling tea, of the same vintage and in the same field, almost closed up, was wilting badly and suffered serious casualties. I can only assume that the V.P. material with its system of root multiplicity, is more able to find nutrient and moisture which is denied to the normal plant solely reliant on its tap root and a few laterals.

It is not perhaps generally realised that the V.P. bush, with its equally substantial and more balanced root system, is probably enabled thereby to forage and procure nourishment which is denied to the ordinary seedling bush.

Costs.—After nursery establishment and preliminary research, I do not think there is any significant difference in the costs of bringing the two types of tea into production. As I have indicated above, the normal nursery procedure can largely be followed, and there is no justification for the tremendous additional nursery expansion and transport costs involved in cylinder transplantation in large scale replantings. The cost of tea seed to the estate is also avoided by the use of leaf cuttings.

Layering.—All clearings since 1948 have been "layered", and, although this technique is not confined to V.P. areas, I am personally confident that it has contributed to a very great extent in securing the satisfactory yields obtained. Unfortunately no "control block" was left in either the V.P. or seedling areas so that the full effect of its influence on yield cannot be ascertained.

Conclusions.—The real value of the experience gleaned in V.P. commercial practice over the last 10 years is, to my mind, the significant data given in comparative yield records *vis-a-vis* counterpart seedling areas, and, although further improvement can be expected, this comparison is reflected in the yield figures of 2,370 lbs. per acre (V.P.) against seedling returns for tea treated, similarly in every way, of 1,231 lbs. per acre. The fields are adjacent, the soil conditions identical and the stand 6,000 to the acre. On a percentage basis the comparison reads $\frac{2,370}{1,231} \times \frac{100}{1} = 193$ per cent., or in other words V.P. yields can be expected to be almost twice as high as those of seedling tea. It should also be remembered that the yields given above refer to 100 primary selected clones, most of which have now been discarded as inadequate, so that with future replantings, restricted to the use of the 20 clones finally selected as outstanding, further very considerable improvement can be confidently anticipated.

The experience here in regard to comparative yields is borne out by the T.R.I. experiments and similar data gleaned from other planters in the low-country.

The V.P. and seedling plants are generally indistinguishable in appearance, size and vigour, and the only conceivable reason for the better performances of the V.P. areas is in the multiplicity of plucking points and profusion of available flush. In addition, all selected clones have a strong and vigorous root system.

General.—It would appear to be the Government policy to encourage expansion of the island's tea areas, and the figure of an additional 100,000 acres has been mentioned as the immediate target.

It seems vital, therefore, that the best possible material should be utilised and, from the data supplied by the Tea Research Institute and from the experience of practical planters, it is incontrovertible that V.P. tea is capable of commercial yields of 3,000 lbs. per acre or more, or nearly double that obtainable by using selected seed. Experience has also shown that the development of V.P. must inevitably be through the individual estate and needs consistant and long term planning in the selection of mother bushes, nursery technique, and planting out.

Apart from the possibility of clonal seed development there is no short cut, and I would assess the time factor between selection of suitable mother bushes and planting out at a minimum of 6 years in the low-country, and probably 8 or more at higher elevations, if really proved material is to be utilised.

In other words, after about 8 years of experimental work, it is only now, after planting out 74 acres of V.P. tea and recording yield tests of many promising and 20 outstanding clones, that this estate is in a position to be completely confident that the best V.P. material (both estate and T.R.I.) suitable for local conditions, is being utilised.

I do not think that further discards will be necessary, as the danger of large monoclonal blocks (manufacture, disease, etc.) should not be minimised and I am reasonably confident that all finally selected clones will give a yield of upwards of 3,000 lbs. per acre on a stand of 5,000.

THE TEA LEAF-EATING TORTRIX CATERPILLAR *(HOMONA COFFEARIA)* NIETN.) AS A LIMITING FACTOR IN INSECTICIDAL APPLICATIONS ON TEA

B. A. Baptist

INTRODUCTION

The natural populations of many insects are controlled by biological factors, especially the presence or absence of other insects which may destroy them through parasitism. These parasites are very much smaller and more delicate than the hosts which they destory and are thus more liable to be destroyed by any insecticidal applications given to the host crop. One of the most important leaf-eating pests of tea, the tortrix caterpillar, is kept in check by such a parasite under natural and normal conditions. Any routine, repeated, insecticidal applications on tea, such as may be used for the control of shot-hole borer, a small ambrosia beetle which bores into the stems of the plant, will, therefore, include the potential danger of upsetting the natural and desirable balance between the tortrix caterpillar and its controlling parasite. Hence, it is desirable to follow up any repeated applications of insecticides on tea for whatever purpose they may be made, from the point of view of possible tortrix caterpillar pest damage. In the present work this is done in connection with specific insecticidal applications carried out for the control of the shot-hole borer beetle of tea, *Xyleborus fornicatus* Eich.

THE PEST INSECT

Occurrence and Distribution.—The tea tortrix caterpillar, *Homona coffearia* Nietn., is an indigenous insect, first recorded by Nietner in 1861 on coffee. Subsequently, when coffee was replaced by tea, the insect transferred its activities to this host plant, acquiring the status of a serious pest. In 1889 an extensive outbreak occurred in the Dimbula and Dickoya districts (Green, 1890). Ten years later it again became serious and subsequently acquired the status of a major, chronic, pest (King, 1933). Its distribution as a pest in Ceylon was chiefly confined to the south west monsoon zone, being most severe in the Maskeliya area, but since about 1937 it has lost its importance as a pest in Ceylon owing to the activities of a parasite from Java, introduced into Ceylon in 1935. The tortrix caterpillar also occurs on tea in North and South India, Indo-China, Java and Formosa.

Life-history and habits.—The detailed life history of the insect in Ceylon, which has been observed by several workers, (Green 1903, Jardine 1918, Hutson 1927, King 1933) occupies approximately 8 weeks from the laying of the eggs to the emergence of the adults, being somewhat longer at higher elevations and shorter at the lower. The actual leaf-eating caterpillar stage occupies 4 to 6 weeks. There are probably 5 generations per year. A characteristic feature about the caterpillar is its habit of webbing leaves together to form a sort of nest within which it feeds. If disturbed it quickly leaves its cover. The feeding of the caterpillar is mainly confined to the young leaves and flush, a large quantity of which may be destroyed by its activities.

Biological relationships.—In an investigation of the pest in 1933, King came to the conclusion that the chief check upon its numbers was a virus or wilt disease, which may account for more than 50 per cent. of the natural mortality found. He also listed several parasites, 1 egg parasite, 14 larval parasites and 2 pupal parasites. Since 1933, 8 more larval parasites and 1 pupal parasite have been recorded (Ranaweera, unpublished). King did not consider any of the indigenous parasites of any economic significance. Attempts were made by Light (1928) and King (1930) to rear egg parasites, *Trichogramma* spp. under artificial conditions and liberate them in the infested areas, but these were not successful.

The idea of importing larval parasites from Java, where the caterpillar was of no significance as a pest, was first mooted in 1931 by King, but it was not until November 1935 that a consignment of parasites was received, among which was the *Macrocentrus* parasite. A further consignment of parasites was received in September 1936. These consignments of parasties were liberated at St. Coombs, Talawakelle, and since then, aided perhaps by a few small liberations in other districts, the *Macrocentrus* parasite has spread extensively and become established in all the tortrix affected tea areas of Ceylon (Gadd 1946).

So effective has this parasite proved to be as a natural controlling agent of the tortrix caterpillar, that the latter is no longer a serious or chronic pest, and by 1939, the Tea Research Institute was able to request the Board of Agriculture to rescind the notification of April 1928, under the Plant Protection Ordinance, No. 10 of 1924, which made it compulsory for affected estates to have the eggs, larvae and pupae of the tortrix collected and destroyed. On the rare occasions on which it has occurred in noticeable numbers since, the degree of parasitism by *Macrocentrus* has been well over 75 per cent. (Gadd 1941).

THE CONTROLLING PARASITE

Macrocentrus homonae Nixon (*Hymenoptera, Braconidae*) was described by Nixon in 1938. It is a minute wasp with a body length of about 4 mm. The female has a long, needle-like ovipositor (5.5 mm.) which projects from the posterior extremity. It deposits its eggs, one at a time, in the bodies of caterpillars, the tea tortrix caterpillar being the normal host in Ceylon. Gadd (1946) gives a detailed description of the bionomics of the parasite. The egg is polyembryonic, one egg giving rise to several parasite grubs inside the body of the host caterpillar. The total life-cycle from egg to adult occupies about 7 weeks. Under laboratory conditions the adult life ranges from 6-24 days, the insect being very active and very industrious in its search for host material throughout its adult life. Any stage from one quarter to three quarters grown caterpillars are quite successfully parasitised. The life-cycle of the parasite and its host are almost coincident, the generations of both insects running more or less parallel.

INSECTICIDAL APPLICATIONS

With a view to eliminating the ravages of the shot-hole borer beetle on tea, routine insecticidal applications were given in certain areas in which also the tortrix caterpillar and its controlling parasite occurred naturally. The details of such applications and the consequent occurrence of the tortrix caterpillar are described in a number of specific cases and the results recorded in tables 1 and 2.

Trial No. 1. (Galbode).—The application was made on a block of $\frac{1}{2}$ acre in a $15\frac{1}{4}$ acre field of 4 year old tea. One acre of this field was blocked out in 1/10 acre plots, 5 of which were sprayed with insecticide and 5 kept as controls. The plots were scattered at random in the block, two rows of bushes being left as a buffer between individual plots. The insecticide application consisted of a spray emulsion of the insecticide dieldrin, at an insecticidal concentration of 0.025 per cent. The

actual product used was Shell Company's Dieldrex 15 at a dilution of 1 in 800 and at the rate of approximately 100 gallons per acre. The first application was given in August 1953 and thereafter applications continued at 10 day intervals up to January 24th, 1955, when the 51st. application was given. Thereafter 5 more applications followed at 2 week intervals and subsequently at 3 week intervals up to September 15th. From June 23rd. to September 15th. the strength of the application was doubled. The application was primarily directed against the frame of the bush but in the process the lower foliage and to a lesser extent the flush also received a certain amount of spray.

No tortrix attack was noticed in the experimental area during the first year of application. In July 1954 the bushes were pruned to 12" and tortrix caterpillars appeared in October-November about 3 months after pruning. The caterpillars were present both in the treated and the control plots, but to a somewhat greater extent in the treated plots. This attack persisted for about 6 months, no special action being taken to control it. In March, April and May of 1955 applications of the insecticide were carried out so as to cover the flush as well as the frame, but these applications did not in any way control the caterpillar. In June a strong foliage application of D.D.T. in the form of a water-dispersible powder at a 0.125 per cent. strength was given. This was effective in nearly wiping out the caterpillar, which subsequently almost disapppeared. The next appearance of the caterpillar in appreciable numbers occurred in early September nearly 3 months later.

At various periods during this cycle collections of caterpillars were carried out and observations made on the degree of parasitism by *Macrocentrus*. These are recorded in table 1.

Trial No. 2. (**Galbode**).—In this trial dieldrin dust (2 per cent. active ingredient) at the rate of 30 lb. per acre was used on a block of 5 acres in a field of 25 acres of recently pruned tea. The first application was made one week after pruning and the second application 12 weeks later. No caterpillars appeared between the first and second applications, but 4 weeks after the second application, tortrix caterpillars were found on the treated block, while the surrounding tea appeared to be free. A 0.125 per cent. D.D.T. application was given at this stage on the flush to destroy the caterpillar. Two weeks subsequently there were few caterpillars, but collections showed that the percentage parasitism obtained was negligible up to 8 weeks after the application of the insecticide.

Trial No. 3. (**Galbode**).—In this trial, a block of 3 acres of recently pruned tea in a field of 20 acres was given an application of dieldrin at a 0.1 per cent. strength in 2 doses. The first was given two weeks after pruning and the second six weeks later. Four weeks after the second application tortrix caterpillar was present on a small scale. A 0.125 per cent. D.D.T. application was given at this stage to destroy the caterpillar. Collections made six weeks after application gave a parasitism of 20 per cent.

Trial No. 4. (**Ingiriya**).—In this trial, 10 plots of 1/10th. acre each in a total field of 33 acres were treated with 0.1 per cent. dieldrin, the first application being given 2 weeks after pruning, and 2 subsequent applications following at 3 week intervals. There was evidence of a very slight outbreak of caterpillar in 2 plots at the time of the last application which was 2 months after pruning. In an examination 6 weeks later there were still a few caterpillars evident and collection revealed a parasitism of only 2 per cent.

Trial No. 5. (**Sanquhar**).—In this trial, a 2 acre block in a field of 24 acres of 6 year old tea was treated with a 0.1 per cent. dieldrin spray, the first application being given 1 week after pruning, the second three weeks after the first, and the third three weeks later. Tortrix caterpillar was evident 2 weeks after the last application and collections in the 12th. and subsequent weeks after pruning (the 6th. and subsequent weeks after the last application) showed negligible parasitism.

Table 1. *Parasitism of tortrix by Macrocentrus in a 1 acre block of which half the area was treated with routine insecticidal spray application of dieldrin* 0.025%

Date of collection	Quantity of material obtained		Number parasitised by Macrocentrus		Percentage parasitism		Remarks
	Treated	Control	Treated	Control	Treated	Control	
20- 1-55	251	104	6	5	2%	5%	Routine application once in 10 days
25- 3-55	261	254	20	16	8%	6%	Routine application once in 14 days from 3-2-55
22- 4-55	139	123	7	23	5%	19%	Routine application once in 21 days from 21-4-55
13-5- 55	68	84	5	7	7%	8%	—do—
18-5- 55	264	140	12	15	5%	11%	—do—
27-5- 55	15	27	1	3	7%	11%	—do—
23-6- 55	62	49	1	2	2%	4%	Additional application of 0.125% DDT given on 22-6-55
14-9- 55	262	109	2	1	1%	1%	Conclusion of routine application 0.05% dieldrin from 23-6-55
21-9- 55	79	64	2	0	2.5%	0%	Additional application of 0.125% DDT given on 15-9-55
28-9- 55	41	36	0	0	0%	0%	
5-10-55	146	63	0	0	0%	0%	

Table 2. *Insecticidal applications on tea in the post-pruning period and subsequent tortrix caterpillar appearance.*

Trial No.	Insecticide used	Area treated	No. of applns.	Period of appln.	Period after pruning	Age of tea	Occurrence of caterpillar after pruning	Intensity of occurrence	Percentage parasitism	Remarks
1	Dieldrin 0.025% spray	½ acre	18	6 months	6 months	5½ yrs.	3rd-6th month	Heavy	5%	No measures taken for caterpillar control
1	Dieldrin 0.025% spray	½ acre	4	12 weeks	9 months	5¾ yrs.	6th-9th month	Medium	5.5%	Appln. of 0.125% DDT given in 9th month for caterpillar control
1	Dieldrin 0.05%	½ acre	4	12 weeks	12 months	6 yrs.	9th-12th month	Slight	1.3%	Appln. of 0.125% DDT given in 12th month for caterpillar control
2	Dieldrin 2% dust	5 acres	2	12 weeks	13 weeks	20 yrs.	15th week	Heavy	0%	2 Applns. of 0.125% DDT given in 16th week. Attack subsided
3	Dieldrin 0.1% spray	3 acres	2	6 weeks	10 weeks	8 yrs.	12th week	Medium	0%	2 Applns. of 0.125% DDT given in 12th week. Attack subsided
4	Dieldrin 0.1% spray	1 acre	3	6 weeks	8 weeks	20 yrs.	14th week	V. slight	10%	Attack disappeared
5	Dieldrin 0.1% spray	2 acres	3	6 weeks	8 weeks	6 yrs.	10th week	Medium	0%	Attack persisted for 3 months
6	Dieldrin 0.1% spray	2 acres	4	6 weeks	7 weeks	4 yrs.	10th week	V. slight	—	Attack disappeared
7	Dieldrin 0.1% spray	2 acres	4	3 weeks	3 weeks	2 yrs.	8th week	V. slight	—	Attack disappeared
8	Dieldrin 0.1% spray	1 acre	4	4 weeks	4 weeks	40 yrs.	None	—	—	—
9	Dieldrin 0.1% spray	1 acre	4	3 weeks	4 weeks	5 yrs.	None	—	—	—
10	Chlordane 0.1% spray	1 acre	3	6 weeks	10 weeks	4 yrs.	12 weeks	Heavy	0%	Appln. of 0.125% DDT given in 12th week

Trial No. 6. (**Sanquhar**).—In this trial, a 2 acre block in a field of 30 acres of 4 year old tea was treated with a 0.1 per cent. dieldrin spray. Four applications were given, the first, one week after pruning, the second, three weeks after the first, the third one week after the second, and the fourth one week after the third, the entire spraying treatment falling within a period of 7 weeks. There was slight caterpillar attack within a month of the last application and a collection of caterpillar made 4 and 5 weeks after this application (12 weeks after pruning) gave negligible parasitism. There was, however, no subsequent attack by the caterpillar.

Trial No. 7. (**Sanquhar**).—In this trial a 2 acre block in a field of 23 acres of 2 year old tea was treated with a 0.1 per cent. dieldrin spray. Four applications were given, the first 2 days after pruning and the subsequent applications at weekly intervals. About 5 weeks after the last application (8 weeks after pruning) there was evidence of very slight tortrix attack with no trace of parasitism. The attack, however, faded out subsequently without any special action being taken.

Trial No. 8. (**Peradeniya**).—In this trial, 1 acre of old tea, comprising four $\frac{1}{4}$ acre plots, was treated with 4 applications of 0.1 per cent. dieldrin spray, the first being given about 4 days after pruning and 3 others following at weekly intervals, the entire spraying being confined to a period of 3-4 weeks after pruning. The pruning adopted in this case was a rim-lung prune. Caterpillars did not appear in this case.

Trial No. 9. (**Endane**).—In this trial, a block of approximately 1 acre in a field of 40 acres of 5 year old tea was treated with four applications of dieldrin at a 0.1 per cent. strength, given at weekly intervals, the first being given 5 days after pruning. No caterpillar attack appeared subsequently in this case.

Trial No. 10. (**Endane**).—In this trial a 1 acre block in a field of 40 acres of 4 year old tea was treated with a cholordane (Intox 8) spray at a 0.1 per cent. insecticidal concentration. The first application was given 4 weeks after pruning, the second 3 weeks later, and the third 3 weeks after the second. Caterpillar attack was severe within 2 weeks of the last spraying or 12 weeks after pruning. An application of 0.125 per cent. D.D.T. was made at this stage to control the caterpillar.

DISCUSSION AND CONCLUSIONS

General observations on the occurrence of the tortrix caterpillar have shown that since the introduction, establishment and distribution of the *Macrocentrus* parasite, which can be assumed to have been effected by 1939, it is extremely uncommon for a tortrix caterpillar outbreak to occur. The life cycles of the host caterpillar and the parasite are almost coincident, the generations of both insects running more or less parallel. This no doubt contributes to the efficiency of the parasite and to the practical lack of divergence in fluctuation of populations of host and parasite. As a result of this close relationship between the life cycles of host and parasite, fluctuations of the physical factors of the environment have an almost equal effect on both insects.

On the other hand chemical factors such as insecticidal spraying, which have an unequal effect on the two insects, may be normally expected to upset the biological equilibrium quite easily. This unequal effect of the insecticide is produced by the relatively greater toxicity of the insecticide to the parasite, which is a very small and delicate insect, as compared to its toxicity to the caterpillar. This is accentuated by the strong residual effect of the insecticide. This very conspicuous difference in toxicity between host and parasite can partly be attributed to the fact that dieldrin as an insecticide appears to have a specially low toxicity towards the tortrix caterpillar.

The main factor which contributes appreciably in producing the conspicuous divergence of the effects of the insecticide on the host caterpillar and parasite populations is the difference in actual habit or behaviour of the insects in question. The tortrix caterpillar usually encloses itself in a protective nest of leaves, inside which it feeds, and thus to some degree avoids the full effect of the insecticidal application. The parasite, on the other hand, not only exposes itself to contact with the treated foliage, but is specially active in searching the foliage for its host; and, having found its host, the indirect approach it has to adopt on account of the concealment of the host caterpillar brings it into still more active and continuous contact with the treated foliage. Such behaviour must necessarily increase mortality of the parasite, caused by the residual effect of the insecticide, very appreciably over that of the host insect, with a consequent preponderance of the caterpillar population. These effects are seen in the persistence of the caterpillar when routine and regular application of insecticide is continued with as in trial No. 1. But even when applications are few and confined to a short period, if these are carried out at a time where there is abundance of young and fresh foliage, the period during which tortrix is normally attracted, an effective reduction of parasitism with consequent increase of caterpillar appears to follow almost invariably. The reduction of the parasitism to practically zero in the majority of cases, even though the treated areas only comprise a fractional part of the pruned field, indicates that the parasite, while very closely following its host, has its effectiveness as a parasite, not just partially reduced as might be expected, but almost totally so. This destruction of the effectiveness of the parasite is likely to persist as long as the residual effect of the insecticide is present. It follows, therefore, that if relatively large, continuous areas, comprising entire fields, are treated with insecticide, there is a strong probability of the upset of the balance persisting for even longer periods, since the restoration of balance would depend on the invasion of parasites from fresh areas outside the treated areas.

From these results, it appears that, if persistent insecticides with highly residual properties are to be used on tea, it will be essential, if subsequent tortrix caterpillar damage is to be avoided, either that the period of application of the insecticide be confined to that period immediately following pruning, when fresh foliage is still not available, or that the application be accompanied or immediately followed by a specific application of an effective insecticide for the destruction of the caterpillar, such as the D.D.T. application given in some of the outbreaks described. In the former case the safe period for application in the case of dieldrin would appear to be limited to the 2-3 weeks immediately following the pruning of the tea. Allowing for a residual effect of a further 2-3 weeks, it may be expected that any parasite coming in 6 weeks or later after pruning is not likely to be affected. It is also unlikely for tortrix to be attracted to fields which are less than 6 weeks from pruning so that no destruction of parasite need be feared within this period. This position is borne out by the cases listed, as the variation in the damage sustained by tortrix caterpillar becomes reduced as the period of application is shortened and taken closer to the pruning time.

In the case of young tea, where some quantity of young foliage may be left behind after the very light pruning which would be normally given, the use of persistent insecticides on it would necessarily have to be carried out in conjunction with a special application of insecticide for tortrix control. It must be remembered, however, that such an application, while effectively destroying the tortrix caterpillar, must have an equal or more intensive effect on the parastie. The most practicable procedure will, therefore, be to give the special application of insecticide for tortrix control within the period in which the residual effect of the primary insecticide, while having no effect on the host caterpillar, is still fatal to the parasite. An alternative will be the restriction of the use of the primary insecticide intended for the shot-hole borer control to such an insecticide as will be more destructive to the caterpillar than to the parasite, or at least equally so. But such an insecticide is hardly likely to be found amongst the persistent group.

Finally, to conclude, the limitation imposed by the tortrix caterpillar on insecticidal applications having highly persistent effects can be summarised as comprising a restriction of insecticide applications to not more than 3 weeks of the immediate post-pruning period in the case of old tea, a similar restriction in application for young tea, in this case accompanied by a surface foliage application of D.D.T. for the control of possible tortrix caterpillar outbreak.

SUMMARY

1. The status of the tea tortrix caterpillar as an economic pest of tea and the biological relationship existing between it and its controlling parasite are briefly given.

2. Ten cases of specific applications of persistent insecticides on a field scale are described with special reference to the subsequent appearance of the caterpillar.

3. The factors relating the insecticide applications to the caterpillar outbreaks are discussed in the light of field observations.

4. Conclusions are drawn that insecticidal applications for the control of shot-hole borer, which are limited to 3 weeks of the immediate post-pruning period, are relatively safe and unlikely to initiate tortrix caterpillar outbreak, except in new clearings where a simultaneous application of a special insecticide for tortrix control is desirable.

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WHY MAGNESIUM?

J. A. H. Tolhurst

Perhaps, before we answer our title, we should ask yet another question—What is magnesium? What is this substance that we should concern ourselves with it in practical agriculture?

As far as can be deduced from the latest developments of scientific research all crop plants demand various proportions of at least fifteen distinct elements for growth, or for existence at all. No one element is more important than the others, in so far as the complete absence of one leads to the death of the plant.

Nitrogen, phosphorus and potassium are three of the fifteen. Air and water provide three more:—carbon, hydrogen and oxygen. What of the other nine?

Magnesium is one of these, an essential plant food, no more and no less. It is indeed unfortunate that certain medicinal derivatives of magnesium should be well known for their dramatic effects on humans, but, as far as plants are concerned, magnesium is merely part of the normal food supply which the plant is continuously attempting to draw from the soil and air. The most distinctive feature of crop plants is the green pigment in the leaf, chlorophyll, which substance is essential for the operation of the initial stages of manufacture of the various organic compounds which will eventually be built up into new plant tissues. Without delving into technical details, chlorophyll contains magnesium. Without magnesium it ceases to exist as an active substance.

That is only one of the functions of magnesium in the plant, but enough has been said to show why we are concerned with this element in plant nutrition, and it only remains to be shown why we should be concerned with it in evaluating a practical manure mixture. The two aspects are not always identical, since manuring need not necessarily attempt to supply all the essential plant foods. Manuring should aim to ensure a sufficient reserve of those nutrients which the soil and the air cannot itself supply to the crop in the amounts required, and it should be an integral part of any sound agricultural system to try to manure in such a way as to maintain soil conditions in the best possible state. Trouble should be met well before half-way.

Our interest in magnesium lies primarily in the former of these two, since the signs of a soil shortage of magnesium are already shown by tea bushes in many districts. We believe that these symptoms can be in evidence for quite a while before the bush begins to show a falling off in crop, and this fact should be accepted gratefully as giving a chance to forestall trouble. It is easier to cure magnesium deficiency in its early stages than when it has become severe.

This is mainly due to an interaction between magnesium and potash in the soil, and we will take this opportunity of correcting a false impression which is in circulation. At the 1955 Conference we drew a picture of another agricultural crop which had run into difficulty through not using magnesium until the deficiency had become severe, and we mentioned that this had been aggravated by the excessive use of potash. Unfortunately this remark, true though it is, has been seized upon in certain quarters and used as an argument in favour of reducing the present rates of potash manuring in Ceylon tea.

The argument hinges on the definition of "excessive". In the manure mixtures used for the other crop potash was proportionately many times higher than it is in T.R.I. 500, and no one who studies the actual figures could ever say that T.R.I. 500 could be classed as a potash rich manure. This is not the place to discuss the level of potash manuring except to say that the Institute is confident that present day practice and experiments will confirm its suspicions that the proportion of potash in T.R.I. 500 may well need to be increased, and not decreased.

The charge of high potash in present day manures being the cause, or a contributory cause, of magensium deficiency in Ceylon tea is completely without foundation and is misleading.

It is dangerously misleading because it has led to the suggestion to cut down the potash rate in an attempt to stave off the onset of magnesium deficiency. Both chemically and agriculturally this would prove to be a foolhardy policy and the Institute condemns it without reservation. Analogies are useful as long as they are not taken too literally, and the following example will serve to give a general picture of our attitude. Nowadays we do not attempt to cure the diabetic patient by eliminating all sugar from his diet; instead regular doses of the accessory factor insulin are given so as to enable the patient to make proper use of his normal sugar intake. Similarly magnesium deficiency must be cured and prevented by using magnesium manures as a regular feature of the manuring programme.

There is still a tendency to regard manures simply in terms of the crop which they will produce, and to equate them with the net profit at the end of the financial year, but we prefer to remember that the soil requires manuring as much as the plant and that it is dangerous to ignore the changes in soil conditions which go on continuously while we pay too much attention to the account books. There can be few crops as long term as tea and it would be as well to consider manuring in the same light. In fact, a revival of the old fashioned word "husbandry" might be worth while to put things into perspective.

Magnesium manuring should be regarded in Ceylon tea in general as an insurance measure, since only in a few small areas does the deficiency appear to have reached a serious stage. Whether or not estates take this attitude is their concern, but we strongly recommend them to do so, especially as the price to pay is very small in comparison with the prosperity of the tea industry today. It seems as though this view is being accepted at an increasing rate and, as we shall not have results from field experiments for some time, we have decided to give a guide to estates on the understanding that we may modify the suggestions as and when practical results make it necessary. The following article on dolomite represents our present views.

DOLOMITE

J. A. H. Tolhurst

With the ever increasing interest in the prophylactic use of dolomite as a manure in tea growing, it has become necessary to give a more detailed guide for those wishing to apply dolomite. The opportunity will also be taken to clarify the naming of this manure, and to correct an error which has appeared in a widely circulated publication. Finally, it is hoped that this article may relieve some of the increasing burden of advisory queries.

"Dolomite", "dolomitic limestone", and "magnesian limestone" all mean more or less the same thing. Ordinary limestone is calcium carbonate, but when same of the calcium is replaced by magnesium the rock is termed "magnesian limestone". When sufficient calcium has been replaced the rock, which has by then changed its physical properties as well, becomes "dolomite".

"MgO" is merely a chemist's way of expressing the magnesium content of manures. The value of a magnesium manure depends on the percentage of MgO, and it is simply a question of equalling the price with the percentage of MgO to decide if the manure is economical. All magnesian manures should have the MgO content stated. Dolomite, of course, is not water soluble and the total MgO of the rock is the figure which expresses its agricultural value.

Dolomite, with an MgO content of at least 20 per cent., occurs as a mountain forming rock in several areas of Ceylon, and magnesian limestones, with variable MgO contents, are even more widespread. The high grade dolomite is so cheap to produce as a manure that there would be little point in considering working the low magnesian limestones.

Most of the dolomite is mechanically crushed, and the resulting manure has a mixture of particle sizes, including a lot of dust. From an agricultural point of view the dust is useful as a more rapidly acting fraction, but labourers have been known to complain of its irritant action on the eyes and nose. This is common to all dusts, and the crushed dolomite is quite harmless otherwise, either to humans or the tea bush. In these days of human allergy it is possible that an occasional individual may be found who is susceptible to the sharp dust particles.

Some dolomite is reduced to a powder by burning, followed by slaking with water. This is referred to as "burned, slaked, dolomite" as opposed to the "crushed dolomite" mentioned above. It is this process which has given rise to the entirely wrong use of the name "dolomite lime". It is true that this is the product formed when the rock is first burned, but burned lime is a dangerous, caustic, substance until it has been slaked with water.

Reputable manufacturers are, of course, alive to this danger and they ensure that the manure reaches the user in a perfectly safe form. In this form it is chemically rather similar to the "Limbux" slaked lime which, as is well known, is quite harmless.

Our greatest worry is that less scrupulous suppliers may sell burned dolomite which has not been properly slaked, in which case it could be as dangerous as some of the locally produced burned coral lime. Any superintendent who has been burned by this lime will not need to be told that if he uses burned, slaked, dolomite then the onus rests with him to see that the slaking is thorough.

One instance of burns from a badly produced manure, if it should ever happen, would give dolomite in general a bad name. For this reason the Institute has decided to announce a very strong preference for crushed dolomite.

This is not such a cautious attitude as it may seem, because, as stated in the opening paragraph, a very serious error has appeared in a publication which is widely read. This implies that coral lime and dolomite are one and the same, whereas in fact they are not.

Coral lime is made by burning coral and, apart from containing very little magnesium, it does often contain lumps of caustic lime capable of raising severe skin burns. Coral lime has no place in the treatment of magnesium deficiency.

To summarise the definition of dolomite, we may say that the manure should be guaranteed to contain a certain percentage of MgO, which allows the cost to be evaluated, and also to derive from dolomite rock. With the present position in Ceylon there is no excuse for anyone using a worthless product or exposing his labour force to the risk of caustic burns.

We make no apology for having gone to such lengths to define what dolomite is and is not, because we feel it is better to correct some of the mistakes in their early stages and to forestall others.

Method of application.—We can now discuss the application of dolomite, which is fortunately very simple. Bearing in mind that it is a very slow acting manure and that the aim is to give one large dressing to last for some years, we recommend a widely distributed broadcasting with no special cultivation. Weather conditions need not be taken into account.

We have suggested that pruning is a convenient time, as the rate of work will be greater without the impedance of the branches and the broadcasting will be more uniform. It also makes it easier to arrange an estate programme if fields automatically receive dolomite at a fixed stage in the cycle. More will be said about this later. Dolomite will not harm the bushes at any stage of growth, but it is obviously wise to persuade the labourers to keep it off the foliage as with other manures.

If in some districts pruning is done at a busy time of the year, then there is no objection to dolomite being applied, say, in the middle of a drought when work is often short, regardless of the pruning cycle.

Dolomite should not be mixed with the other manures in the bag, but there is no objection to the two manures being together on the ground at the same time. Cultivation could follow immediately and no loss of nitrogen to the atmosphere would occur.

If dolomite is applied several weeks before the other manures then it can safely be left lying on the surface until the next routine cultivation is due.

Dolomite has to have a separate application but this may be as simple as it possibly can be and may be timed entirely to suit the individual estate's convenience.

Rate of application and experimental warning.—Our original idea was that estates, at least in certain districts, might like to try experimental blocks or

fields under one application of 5 cwt. of dolomite per acre. It now seems that many estates are going to go ahead with an overall programme and are by-passing the experimental stage.

It is gratifying to see that there is so much faith in the Institute, but it would not be fair if we failed to remind those concerned that we consider the matter still in the experimental stage. Also, that if an area is not suffering from magnesium deficiency then there will be no benefit from the added magnesium. We may change our recommendations at any time, pending results from experiments, and there may be disappointment in some quarters if dolomite does not send the yields soaring.

We are certainly not going to discourage estates from using dolomite on any scale they may choose, subject to the soil acidity proving safe, because such wide-spread applications naturally increase our own opportunities for estimating the practical effects of dolomite. We would, however, stress that in the majority of soils, as far as we have been able to judge by an all too scanty survey of leaf deficiency symptoms, dolomite will be applied as an insurance measure. If superintendents will extend their faith in scientific research and accept this view, which after all is in the best interests of husbandry, then we shall not hesitate to encourage the general use of dolomite. Over optimistic hopes based on misconceptions of why dolomite is used could be the greatest enemy of this latest addition to the manuring programme. The preceding article on magnesium emphasises this outlook.

Soil pH.—Before applying 5 cwt. of dolomite per acre we have always warned superintendents to send soil samples for a pH check. If the pH is above 5.5 we are not at the moment prepared to recommend dolomite.

If an estate has limestone outcrops on or near the fields to be treated then there is a real danger of the pH being pushed too high, and those estates must contact us for special advice.

Normally, if one field only is to be treated, six separate samples taken from widely scattered points and from the top six inches will be sufficient. This does not appear to conform to the advice given in the *Tea Quarterly* for September 1955, page 112. The necessity for accuracy is not so great when deciding on the use of dolomite, and the limit set, 5.5, allows a very ample margin of safety. If the field is very sharply divided, say by a ridge or a ravine, then it would be better to treat each section as a separate field.

If all the pruned fields on an estate are to be treated then we suggest no more than three samples from each. This will give a total which, both in numbers and in distribution, offers a good basis for detecting any possible trend towards a too high pH.

The numbers of such samples which we are now receiving are on the increase and we can not cope with a very detailed sampling from every field. A suggestion offered by a visiting agent, which we have welcomed very warmly, is that his estates should be supplied with their own pH testing outfits. This is more satisfactory both from our aspect and that of the estate, as many more tests can be made and the results are available immediately.

The B.D.H. Barium Sulphate pH outfit is very cheap and perfectly simple to operate. Before an estate puts it into routine operation soils could be sent to the Institute, so that the pH value obtained by the barium sulphate method may be compared with that given by the more precise method we adopt.

Cost.—A question often asked concerns the relative cost of dolomite and Epsom salts as a source of magnesium. These two manures differ widely in their speed of action, but if the aim is to maintain the magnesium reserves in the soil then we may compare them directly on their magnesium content.

This is expressed as percentage MgO, and it will be found that the manures offered for sale have, for Epsom salts 16 per cent. MgO, and for dolomite, a minimum of 20 per cent. MgO.

Prices vary, but by weight Epsom salts is from two to two and half times as expensive as dolomite. It is only a matter of arithmetic to show that on an equivalent MgO basis, Epsom salts is thus between two and three times as expensive as dolomite.

Dolomite has to incure the cost of a separate, simple application, whereas Epsom salts is incorporated with the normal manure. Even allowing for this, which again varies widely, dolomite is still far cheaper. This, of course, is putting the comparison at its face value. Each manure has its own peculiarities and additional effects on both plant and soil, and until all these are sorted out by experiment an absolute comparison can not be hoped for. Our anticipation is that these additional factors will only shift the balance still more in favour of dolomite.

INTERIM REPORT ON THE PERFORMANCE OF THE "SHIZUOKA" ELECTRIC SEPARATOR.

E. L. Keegel and S. M. Gunaratnam

This machine, which was introduced recently into Ceylon for separating stalk from tea, has, since its first appearance, aroused considerable interest amongst all connected with the tea industry. Claims were made that by its use the long and tedious process of hand picking would be eliminated.

The feature of this new approach to the problem of extracting stalk is the employment of the basic principle of electrostatic separation, which has proved successful in the mining and metallurgical industry. In adopting this principle in the case of tea, the manufacturers of the machine have recognized the existence of a difference in the electric susceptibility between particles of tea and stalk, brought about partly by a difference in moisture content and partly by a difference in the general structure. In consequence, when a mixture of stalk and tea is subject to the effect of a strong electric field, the electric charge induced on the particles will vary according to the difference in surface conductivity. It is this characteristic difference which is utilized by this machine for the removal of stalk.

In the 'Shizuoka' machine the electrostatic field is provided by an insulated roller charged to a high potential from a high tension system, and by another roller, which is earthed. The strength of the field is controlled by the gap between the two rollers and also by the high voltage source. Both rollers rotate, and the tea to be treated is conveyed by means of a moving belt on to the earthed roller, from where it passes through the electrified gap. The more highly charged particles are pulled towards the other roller, whilst the rest follow the natural trajectory. These two fractions are then separated by an adjustable plate.

In brief, the machine consists of five essential parts:—

(i) The feeder.

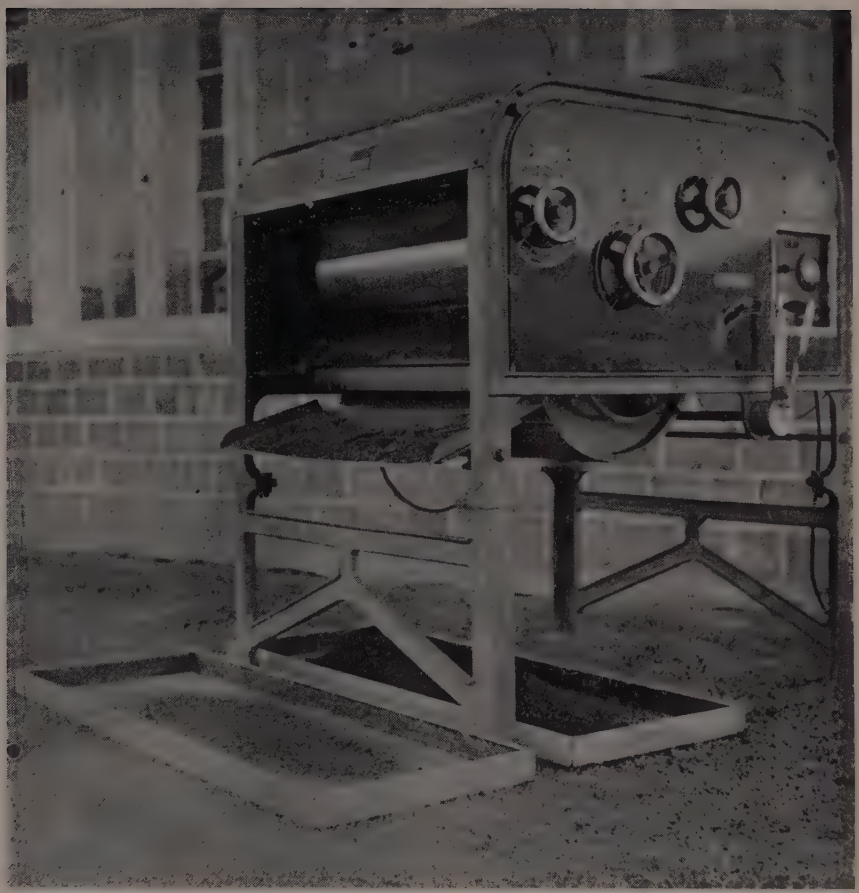
(ii) The conveyor.

(iii) The high tension source.

(iv) The two rollers.

(v) The separating plate.

Each of these is variable and the success or otherwise of the performance of the machine depends entirely on how the adjustments are made in relation to one another. A certain amount of skill and judgment is therefore called for, and can only be acquired by familiarity with the operation of the machine. Once experience is gained, the special procedures required for different types of tea present no serious difficulty. Nevertheless critical control appears to be necessary to get the best results. The efficiency of the machine is therefore determined by a correct co-ordination of the five controls with respect to the type of tea handled.



The photograph above shows a front view of this machine, which is $4\frac{1}{2}'$ high and occupies a space $3\frac{1}{2}' \times 3'$.

The interior construction is not visible, but a part of the rotating roller over which the tea is conveyed can be seen. The receptacle directly below it receives the fraction which is free from stalk, whilst the tray in the foreground collects the separated stalk. The roller in the front carries the high tension charge, which is responsible for attracting the stalk. The adjustable deflector, which regulates the degree of separation of stalk is also visible.

All the controls are situated on the same side. The three wheels which can be seen, adjust the separator, the gap between the rollers and the rate of feed. The hand lever controls the speed of the rollers, and the panel adjoining it holds the electric switches.

The material to be treated is fed into a hopper situated at the top of the machine.

The machine tried out at St. Coombs has so far been used in an experimental capacity only and the results have been most encouraging. They may be summarized as follows:—

(1) All stalk is not completely separated but a considerable proportion of it can be removed.

(2) The separated fraction is not entirely stalk. A certain amount of tea finds its way into the stalky fraction, retreating of which still does not bring about a true separation. However, owing to the stalks being concerntated in a relatively smaller amount of tea, a separation is more easily effected by hand-picking.

(3) Heavy stalk defies separation, the force of attraction of the charged roller not being sufficiently strong to overcome the weight of the stalk.

(4) There appears to be no difference in the degree of separation between freshly fired teas and teas stored for some time.

(5) The machine cannot be used with success for unsifted teas, probably because of the uneven sized particles being 'electrified' differently.

(6) The best degree of separation is obtained with graded teas, particularly the small sized grades such as Fannings and Dusts. Orange Pekoe on account of its peculiar structure does not lend itself to easy separation. For a similar reason tightly twisted big bulk is not suitable material to treat. Excellent results are however obtained with a big bulk comprising flaky leaf and light stalk.

(7) The machine also removes fibre and a certain type of stalk which is most difficult, almost impossible, to separate by the usual winnowing methods.

(8) In the case of the B.O.P. grade, a fraction almost free from stalk, of about the same standard as a hand-picked tea, can be obtained. Hand picking of the other fraction, which amounts to nearly 10 per cent. of the weight of treated tea, is necessary.

An almost perfectly clean separation can be secured when Fannings and Dusts are passed through the machine.

The Broken Pekoe and Pekoe grades, which generally contain heavier stalk, do not give such satisfactory results, and the indications are that little is to be gained by employing the principle of electrostatic separation for these two grades. It is very unlikely that even with a stronger electric field it would be possible to get a reasonable measure of success.

(9) The machine is particularly efficient in separating the rubbish from off-grades, which cannot be separated by other devices.

(10) The output of the machine varies of course with the size of the particles of tea, the rate at which it is fed, and the fineness of separation required. Roughly speaking, it is capable of handling about 200 lb. of B.O.P. or cut leaf per hour, and a quantity of up to 500 lb. of Fannings, Dusts or off-grades.

(11) The current consumption by the high tension supply is extremely low, being only 100 watts. The cost of operating the machine is therefore virtually the cost of running the $\frac{1}{4}$ h.p. motor used for driving the conveyor belt and rollers.

From the results obtained so far there is no room for doubt that the electric stalk separator is an asset in a tea factory. Although not a hundred per cent efficient, it can be used for a part of the day's make as a general utility machine for B.O.P., Fannings, Dusts and off-grades. Even though it is not especially useful for other grades, the overall cost of hand picking can be susbtantially reduced by at least 50 per cent. There is reason to hope that picking costs can be reduced further if certain technical modifications are incorporated. For instance,

(i) Improved spreading of the tea by the use of say a vibrator.
(ii) A variable speed for the charged roller.
(iii) An additional stage of separation by the introduction of another pair of rollers.
(iv) A stronger electric field.
(v) An extra hopper for collecting the 'middlings'.
(vi) A more easily adjustable deflector.

We consider that these further improvements are required for the machine to be adaptable for the many different types of tea produced in Ceylon. Still, in its present form it serves to fill a long felt gap in the processing of tea. But for use on a commercial scale there are yet a few urgent requirements.

These are:—
(i) Complete protection from electrically charged parts of the machine.
(ii) A better feeding device.
(iii) More precise controls.

Much of the manipulation now needed in the operation of this machine may well be done away with by the refinements suggested. If these are provided it would not be difficult for an intelligent labourer to manage the machine properly after a few days experience.

Particulars of cost, and other details can be obtained from the sole agent, Mr. P. P. P. Jinadasa, Meddawatte, Matara.

APPENDIX

Since the above was written we have been informed by the agent that in the latest machines the following modifications are to be made:—

(1) An improved feeding system which ensures an uniform spread of tea.

(2) The introduction of an elevator to enable the tea to be passed through again. With this arrangement there will be no need for the tea to be carried and fed at the top of the machine.

(3) A more easily adjustable deflector.

(4) Protection of the electrically charged roller by means of a transparent Perspex panel or nylon mesh.

(5) More precise controls (The manufacturers give the assurance that there is no fear of these going out of adjustment with use).

(6) Safer operation. The high voltage source will be modified and the roller at the high potential will no longer retain the electric charge after the current is switched off.

We have also been informed that the machine carries a one year's guarantee and free service during this period. The cost of a machine operated from any A.C. supply is Rs. 6,500/-. A.D.C. model will cost a little extra.

MISCELLANEOUS NOTES

MANURING GUATEMALA GRASS

J. A. H. Tolhurst and G. B. Portsmouth

An increasingly frequent advisory query concerns the recommended manure mixture for Guatemala grass, and occasionally for manna and napier grasses. This note represents the latest conclusions which have been drawn from field experiments carried out over several years by the Chemistry and Plant Physiology Departments. The main experiment was on Guatemala grass, but it may be taken that the same mixture will be equally suitable for napier and manna grasses, the latter being in a pure stand.

The mixture recommended is now:—

Sulphate of ammonia	5 parts by weight
Superphosphate	3 parts by weight
60 per cent. Muriate of Potash	2 parts by weight

This mixture may be changed if further developments in the experiments warrant an alteration.

A suitable adjustment may be made if 50 per cent. muriate is used instead of the normal 60 per cent. muriate. However, failure to do so is unlikely to materially affect the general usefulness of the mixture for grasses, since there is a fairly wide latitude in their nutrient requirements according to prevailing conditions of growth.

The method of application should be broadcasting, followed by light forking, and the usual relation to weather holds good, as for tea.

It is not possible to give a fixed rate of application, as these grasses vary so much in their growth in different climatic districts. In general we suggest the following:—

At planting	2 cwt. per acre
At each cut	2-4 cwt. per acre

Rapid growth will of course be allowed for to some extent by the more frequent cutting, together with manuring. The figure of 4 cwt. per acre must not be taken as a maximum, which can only be determined by the superintendent for his own particular conditions. If the yield is found to pay for the higher rate of manuring, then it is purely a question of estate policy whether or not an even higher rate is tried.

When the loppings are carried off to thatch other areas, then it would be wise to manure at the 4 cwt. level. When they are allowed to rot in the same area as they are grown, then the level adopted depends on the desire to build up soil fertility.

These remarks only apply to plantings which are large enough to be treated as separate units, and it would be sufficient to manure very small patches in the tea as though each grass plant was a tea bush. Such small patches or isolated plants on banks, etc. must be manured in addition to the neighbouring tea bushes or else the latter will suffer from the competition. The grass must also be kept well cut or, again, competition will adversely affect the tea.

Our only experience with manna grass has been that when virgin patna, which to the eye was nearly all manna, was manured, then the smaller grasses responded so vigorously that the manna grass was actually weakened as a result of the increased competition which developed. It is known, however, that both manna and napier grasses respond in the expected way to manuring when they are planted in pure stands.

MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON, HELD AT THE OFFICES OF THE PLANTERS' ASSOCIATION OF CEYLON, COLOMBO, ON FRIDAY, 2ND. DECEMBER 1955, AT 10-00 A. M.

Present.—Messrs. H. S. Hurst (Chairman), A. D. McLeod (Chairman, Agency Section, Planters' Association of Ceylon), R. H. Wickramasinghe, M.B.E. (representing the Minister of Finance), D. C. L. Amarasinghe, C.C.S. (Tea Controller), Senator E. W. Kannangara, C.B.E. (Chairman, Low-Country Products Association), Dr. W. R. C. Paul (Acting Director of Agriculture), Messrs. R. C. Scott, C.B.E., G. K. Newton, J. L. D. Pieris, N. B. Parker, G. J. Harris, B. Amarasuriya, R. M. Macintyre, F. Amarasuriya, V. G. W. Ratnayaka, M.B.E., M.P., U. B. Unamboowe, O.B.E., M.P., A. Divitotawela and G. B. Portsmouth (Director and Secretary).

Also.—Messrs. G. A. D. Kehl, E. S. Rose and J. V. Harbord (T.R.I.).

A letter, regretting his inability to attend, was received from Mr. K. G. Sinclair.

1. Notice convening the meeting was read.

The Chairman announced to members that Major J. W. Oldfield, C.M.G., O.B.E., M.C., E.D., had died the previous day. Major Oldfield had been a prominent member of the community for many years, and had been the first Chairman of the Board of the Institute. He asked members to pay their respects in the usual manner.

The Director said that he had sent two wreaths, one on behalf of the Board and one from the Institute, to the funeral, which was being held that afternoon.

Members asked that a letter of condolence should be sent to Major Oldfield's family.

The Chairman welcomed Messrs. Scott and Parker back to the Board after their leave. He also welcomed Dr. Paul, who was acting for Dr. Joachim, and Mr. Macintyre, the new representative of the Agency Section of the Planters' Association.

2. **Minutes of the Board Meeting held on 2nd. September, 1955**

The minutes were confirmed.

3. **Membership of the Board and Committees**

It was reported that:—

(i) Messrs. Scott and Parker had resumed their places on the Board.

(ii) Dr. Paul was acting as an ex-officio member in place of Dr. Joachim, who was away from the island.

(iii) Mr. Edwards had resigned the chairmanship of the Agency Section, Planters' Association, and was no longer a member of the Board. He had been succeeded by Mr. McLeod.

(iv) Mr. Macintyre had been nominated by the Agency Section, Planters' Association, to succeed Mr. McLeod.

(v) Mr. Green had resigned and Mr. Harris had been nominated to succeed him by the Agency Section, Planters' Association.

The Board recorded its appreciation of the services rendered by Messrs. Green and Edwards during their period as members, and by Messrs. Hawkes and Cathcart, who had acted for Messrs. Scott and Parker respectively.

The Board agreed that:—

(i) Mr. Macintyre should fill Mr. McLeod's place on the Finance Committee. Mr. McLeod remained on the Committee ex-officio, in place of Mr. Edwards.

(ii) Mr. Sinclair should take Mr. Edward's place on the Standing Committee.

4. **Minutes of the Small Holdings Sub-Committee Meeting held on 1st. September, 1955**

The minutes were approved.

5. **Minutes of the Finance Sub-Committee Meeting held on 2nd. September, 1955**

The minutes were approved.

6. **Minutes of the Meeting of the Committee of Management, Junior Staff Medical Fund, held on 2nd. September, 1955**

The minutes were approved.

7. **Minutes of the Meeting of the Trustees, Junior Staff Provident Fund, held on 2nd. September, 1955**

The minutes were approved.

8. **Minutes of the Standing Committee Meeting held on 4th. November, 1955**

(i) Water Supply Scheme.—The Director reported that Mr. Gibbs, the Engineer in charge of the Kalatuwawa scheme, had been given permission by the Colombo Municipal Council to assist the Institute to implement its water supply scheme. Mr. Gibbs was preparing an estimate of the cost of the scheme, which would be ready for submission at the next Board meeting.

(ii) Billiard Table.—The Director reported that he had seen the table at Caledonia Estate and considered it unsuitable. A sum of Rs. 6,000/- was approved to cover the purchase from Chands of a table reconditioned in the United Kingdom. This sum covered all the necessary accessories, transport from Colombo and installation at St. Coombs.

(iii) Director's leave.—The Director's request for five weeks leave to make a cruise to Japan was approved. The Standing Committee's recommendations regarding terms for the Director were also approved.

The Board agreed that Mr. Harbord should be authorised to carry on the day to day administration of the Institute, under the direction of the Chairman, during the Director's absence from Ceylon.

The remainder of the Standing Committee minutes were approved in toto.

9. Minutes of the Experimental and Estate Committee Meeting held on 5th. November, 1955

The minutes were approved, subject to the amendment to the St. Coombs Estate estimates, recommended by the Finance Committee at their meeting on 1st December, 1955.

10. Estimates for 1956

(i) St. Coombs Estate.—Approved subject to the following amendment to Item 64, Waterborne sanitation to lines.

For 172 waterborne lavatories and bathing places at Rs. 116,370/-
read 60 ,, ,, ,, ,, ,, at Rs. 40,600/-

This reduction was recommended by the Finance Committee, which considered the larger estimate unrealistic.

(ii) Small Holdings Advisory Service.—Approved subject to the following amendment, as recommended by the Small Holdings and Finance Committees:—

Item 9A, Insurances. For Rs. 475/- read Rs. 1,185/-. This increase was to provide personal insurance for the small holdings staff on a similar scale to that provided for the junior staff at the Institute.

(iii) Tea Research Institute.—Approved in toto.

11. Any other Business

(i) Letter from Mr. Austin.—The Chairman read a letter from Mr. Austin, offering to continue in the service of the Institute for a further two years as a member of the senior staff on a fixed contract. The Director strongly recommended the acceptance of Mr. Austin's offer. Mr. Austin's knowledge of shot-hole borer was invaluable, and he and Dr. Judenko made an excellent team. Several members spoke highly of Mr. Austin's work and past service, and it was agreed to accept his offer on the terms suggested in his letter.

(ii) Theft of Standing Committee Minutes.—The report of the Committee of Enquiry held on 22nd. November, 1955, was read in full, and the action of the Committee was endorsed by the Board.

(iii) Letter from Mr. Loos, dated 24-11-55.—Mr. Loos's submissions were rejected in toto.

(iv) Appointment of new Chairman.—Mr. Hurst said that the time had now come for him to vacate the Chair, and he put forward the name of Mr. Sinclair as his successor.

Mr. Newton spoke warmly of Mr. Hurst's services to the tea industry in general, and the Institute in particular, during his long career in Ceylon. He proposed a vote of thanks to Mr. Hurst, which was carried with acclamation.

On Mr. Newton's proposal, seconded by Mr. Ratnayaka, Mr. Sinclair was unanimously elected Chairman.

The Director then paid a tribute, both on behalf of the Institute and of himself personally, to Mr. Hurst for the help which he had so unstintingly given. Mr. Hurst was the latest of a distinguished line of Chairmen, and had carried on in the best traditions of his predecessors.

The Chairman thanked the Board for their kind words, and the meeting terminated at 3-55 p.m., with a vote of thanks to the Chair.

Sgd. G. B. PORTSMOUTH,
Secretary.

Tea Research Institute of Ceylon,
St. Coombs,
Talawakelle.

MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD AT THE OFFICES OF THE PLANTERS' ASSOCIATION OF CEYLON COLOMBO, ON FRIDAY, 2ND. MARCH, 1956, AT 9-00 A.M.

Present.—Messrs. K. G. Sinclair (Chairman, Planters' Association of Ceylon) (Chairman), A. D. McLeod (Chairman, Agency Section, Planters' Association of Ceylon), Senator E. W. Kannangara, C.B.E. (Chairman, Low-Country Products Association), Dr. A. W. R. Joachim, O.B.E. (Director of Agriculture), Messrs. D. C. L. Amarasinghe, C.C.S. (Tea Controller), R. C. Scott, C.B.E., G. K. Newton, J. L. D. Peiris, N. B. Parker, R. M. Macintyre, B. Amarasuriya, W. H. W. Coultas, G. J. Harris, A. Divitotawela and G. B. Portsmouth (Director and Secretary).

By invitation. Mr. U. B. Unamboowe, O.B.E.

Also.—Messrs. G. A. D. Kehl and J. V. Harbord (T.R.I.).

A telegram from Mr. Ratnayake, a letter from Mr. Wickramasinghe and a message from Mr. F. Amarasiurya (from hospital) was received, regretting their inability to attend.

1. Notice convening the meeting was read. The Chairman welcomed Mr. Coultas, the new member, and Mr. Unamboowe, present by invitation.

Mr. Unamboowe referred to the correspondence between himself and the Chairman regarding the publication of his letter of February 6th. in the press, and repeated his previous assurance that he himself had given no information to the press. This assurance was accepted and Mr. Unamboowe was invited to remain for the rest of the meeting.

2. Minutes of the Board Meeting held on 2nd. December, 1955

The minutes were confirmed.

3. Matters arising out of the Minutes

(i) **Water Supply Scheme, St. Coombs.**—A report by Mr. Gibbs, giving his proposals for the St. Coombs water supply augmentation scheme, was tabled, and, after persual by members, approved in principle.

(ii) **T. R. I. Estimates.**—It was reported that the question of audit fees was under discussion with the auditors.

4. Membership of the Board and Committees

It was reported that:—

(i) Mr. W. H. W. Coultas had been nominated by the Planters' Association to replace Mr. H. S. Hurst (resigned), as from 14-2-56.

(ii) Mr. U. B. Unamboowe had ceased to be a member of the Board with the dissolution of Parliament on February 18th, 1956.

It was agreed, on the proposal of Mr. McLeod, that Senator Kannangara should serve as an ordinary member of the Standing Committee in place of Mr. Sinclair, who was now an ex-officio member of the Committee.

5. Minutes of the Small Holdings Committee Meeting held on 1st. December, 1955

The minutes were approved.

6. Minutes of the Finance Committee Meeting held on 1st. December, 1955

The minutes were approved.

7. Minutes of the Building Committee Meeting held on 21st. December, 1955

Mr. Peiris reported that plans were available of a senior staff house and a junior staff house. After inspection these plans were approved by members.

The Building Committee were also instructed that plans for enlarging the Guest House at St. Coombs should be drawn up.

The minutes were approved.

8. Minutes of the Appointments Committee Meeting held on 21st. December 1955

Dr. Visser's appointment had been approved by the Board by circulation of papers (Circular A. 1/56 of 7-1-56). 16 members assented. There were no dissenters. The minutes were formally approved.

9. Minutes of the Standing Committee Meetings held on 21st. December, 1955 and 14th. February, 1956

(i) **The case of Dr. Baptist.**—The Chairman reported that all correspondence in connection with Dr. Baptist had been circulated except:—

(*a*) Mr. Unamboowe's letter to the Chairman dated 15-2-56.

(*b*) The Director's report on Dr. Baptist dated 27-2-56.

(*c*) A memorandum by Dr. Baptist dated 25-2-56, to which was attached a letter dated 27-2-56 to the Chairman.

(*a*) and (*b*) above had been tabled, and (*c*) had been circulated directly to all Board members by Dr. Baptist.

Considerable discussion then followed. Many members expressed strong resentment regarding the virulent press campaign which had developed in connection with the present case and expressed the hope that any decision reached would not be influenced by it. The Board must not allow itself to act under duress.

All members having been given the opportunity to express their views, on the proposal of Senator Kannangara, seconded by Dr. Joachim, the following motion was then put to the meeting.

"That notice of termination of Dr. Baptist's contract as decided at the meeting of 2-9-55 be withdrawn, and that other suitable disciplinary action be taken."

On being put to the vote the motion was defeated by 10 votes to 3. Mr. B. Amarasuriya declined to vote, in view of the fact that he had not been present at the September meeting.

Mr. Unamboowe then left the meeting.

(ii) **Resignation of Mr. Loos.**—All papers in connection with Mr. Loos had been circulated. His due leave pay had been paid. It was reported that Mr. Loos had left Ceylon on February 19th.

(iii) **Small Holdings Advisory Service.**—The Standing Committee's recommendation not to press for a transfer of the service to the Tea Controller at the present time was approved, and it was agreed that the Minister of Agriculture and Food should be informed accordingly.

The minutes of the Standing Committee meetings of 21st. December 1955, and 14th. February 1956, were formally approved.

10. Minutes of the Experimental and Estate Committee Meeting held on 18th. February, 1956

Mr. Peiris asked whether clones approved by the T.R.I. would be released free to estates. Mr. Portsmouth said that the Planters' Association had agreed to this, and that clones were now only accepted for proving on the understanding that they could be released free of charge.

The minutes were approved, subject to a comment by Mr. McLeod.

Senator Kannangara seconded the proposal which was unanimously accepted.

Mr. Amarasuriya in taking the Chair thanked members for the honour bestowed on him. He assured them that he would do everything possible to maintain the prestige of the Board and asked members for their co-operation and support.

On behalf of the Board he wished Mr. & Mrs. Sinclair a happy retirement in the United Kingdom and best wishes for the future. Senator Kannangara seconded.

The Director assured the new Chairman of his wholehearted assistance in carrying out his duties and looked forward to a happy and fruitful collaboration in the years to come. He also paid tribute to Mr. Sinclair, who had been a tower of strength in the very difficult times the Institute had experienced recently. On behalf of the staff of the Institute he wished Mr. & Mrs. Sinclair all success in the years to come.

The meeting terminated at 4-15 p.m.

Sgd. G. B. PORTSMOUTH,
Secretary.

Tea Research Institute of Ceylon,
St. Coombs,
Talawakelle.

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